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Overview: Monitoring of Bathurst and Bluenose-East Caribou Herds, October 2014

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ABSTRACT

This document provides an overview up to October 2014 of population trend, other monitoring, and management of the Bathurst and Bluenose-East caribou herds in the Northwest Territories and Nunavut, with the emphasis on the five years from 2009-2014. Results from a reconnaissance survey conducted in June 2014 on the calving grounds of the Bathurst herd suggested that this herd, which had been considered stable 2009-2012, had declined since 2012. Results from calving ground photo surveys of the Bluenose-East herd indicated this herd had declined substantially 2010-2013. The June 2014 calving ground reconnaissance survey results suggested the Bluenose-East herd had continued to decline rapidly. Photo surveys were planned for June 2015 to provide more precise population and trend estimates for both herds.

Two main sections of this overview describe results of population surveys, calving ground reconnaissance surveys, estimates of cow survival rate, spring recruitment surveys, fall composition surveys, pregnancy rates, harvest estimates, movements of collared caribou between neighbouring herds, and the management context for each herd. Information on wolf monitoring on the Bathurst range and recent wolf harvest is included. A section on long-term cycles or fluctuations of migratory caribou herds and demographic indicators of decline (low pregnancy rates, low calf recruitment and low adult cow survival) follows. The overview concludes with assessments of population trend in the Bathurst and Bluenose-East herds 2009-2014 and possible explanations for the June 2014 calving ground reconnaissance survey results.

For the Bathurst herd, the likeliest explanation for the low numbers of caribou on the calving grounds in 2014 is a combination of low natural survival rates, reduced calf productivity and survival, and to some extent harvest. Harvest of the Bathurst herd on its main winter range (management zones R/BC/02 and R/BC/03) has been greatly reduced since 2010 but some harvest likely continues and is unreported and some harvest has likely occurred outside these zones. For example, harvest of Bathurst caribou may have occurred in some winters in R/BC/01, where the Bathurst and Bluenose-East herds have

overlapped in some winters. Issues related to the reconnaissance survey methods may have affected survey results but are unlikely to account for the large apparent drop in numbers of caribou on the calving grounds. Assessment of movements of collared caribou between the Bathurst's calving grounds and its neighbouring herds' calving grounds showed no evidence of large-scale emigration from the Bathurst range 2010-2014.

For the Bluenose-East herd, a combination of low natural survival, reduced calf recruitment, low pregnancy rates in some years, and a substantial cow harvest are the most probable reasons for the herd's substantial decline 2010-2013 and the continued and potentially accelerated decline to June 2014. Issues related to the reconnaissance survey methods may have affected the survey results but are unlikely to account for the large apparent decrease in caribou on the calving grounds. Assessment of movements of collared caribou between the Bluenose-East's calving grounds and its neighbouring herds' calving grounds showed no evidence of large-scale emigration from the Bluenose-East range 2010-2014.

TABLE OF CONTENTS

ABSTRACT iii
LIST OF FIGURES viii
LIST OF TABLES xi
INTRODUCTION 1
BATHURST HERD 4
Population Surveys 4
Calving Ground Reconnaissance Surveys 5
Adult Cow Survival Estimates 8
Spring Calf Recruitment Surveys 9
Fall Composition Surveys 12
Pregnancy Rates 13
Harvest Estimates 15
Wolf Monitoring and Harvest 20
Summary of NWT Wolf Project 2013/2014 22
Wolf Harvest in the North Slave Region, 2009-2014 24
Movements of Collared Bathurst Caribou to other Ranges 25
Management Context for the Bathurst Herd 26
Overall Bathurst Herd Management 26
Short-term Management 27
Land Management 28
BLUENOSE-EAST HERD 29
Population Surveys 29
Calving Ground Reconnaissance Surveys 31
Spring Calf Recruitment Surveys 33
Adult Cow Survival Estimates 33
Fall Composition Surveys 33
Pregnancy and Condition 34
Harvest Estimates 36

Movements of Collared Bluenose-East Caribou 37
Management Context for the Bluenose-East Herd 38
CARIBOU CYCLES AND DEMOGRAPHICS OF DECLINE 40
Caribou Cycles 40
Factors that Drive Cycles 43
DEMOGRAPHICS OF DECLINE IN CARIBOU 47
BATHURST AND BLUENOSE-EAST POPULATION TREND IN 2014 48
Bathurst Herd in 2014 48
Survey-Related Factors 48
Biological Factors 51
Bluenose-East Herd in 2014 52
Survey-related Factors 52
Biological Factors 55
PERSONNAL COMMUNICATION 57
LITERATURE CITED 58
APPENDIX 1. BLUENOSE EAST CARIBOU HEALTH AND CONDITION MONITORING 2010-2014 PRELIMINARY RESULTS 62
Hunter Sampling Kits 62
Hunter Caribou Collection and Sampling Summary 62
2010 62
2011 62
2012 63
2013 63
2014 63
Age Estimated by Hunters 63
2010 63
Tooth Cementum Age 64
2010 64
2011 64
2012 65

2013 65
2014 Age Pending 65
Field Assessment of Condition (Submitted by Hunters) 66
2010 66
2011 67
2012 67
2013 67
2014 68
Back Fat Measurements 68
Kidney Fat 69
Bone Marrow Fat 71
Pregnancy Rates 72
Pregnancy Data for Collared Caribou March 2012 73
2010 73
2012 73
2014 73
Kidney Fat Index in Relation to Pregnancy 73
APPENDIX 2: STABLE, DECLINING AND INCREASING CARIBOU HERDS: A SIMPLE VIEW OF THE NUMBERS 75

LIST OF FIGURES

Figure 1. Bathurst, Bluenose-East and neighbouring caribou herds annual ranges based on collar locations 2006-2012.....2

Figure 2. Female and male caribou.....3

Figure 3. Estimates of breeding female and adult caribou (1.5-year-old+) in the Bathurst herd 1986-2012.....4

Figure 4. Trend in numbers of caribou at 1-year-old or older on the Bathurst calving grounds 2006-2014.....5

Figure 5. Snow cover on the Bathurst calving ground June 9, 2013, reconnaissance lines flown that day, and reconnaissance lines flown June 13, 2013.....6

Figure 6. Flight lines flown on June 8-9 2014 reconnaissance survey of Bathurst calving ground.....7

Figure 7. Movements of collared caribou to the Bathurst calving ground area, May 12 to June 6, 2012.....8

Figure 8. Adult cow caribou mortality rate compared to population rate of change in barren-ground caribou herds.....9

Figure 9. Correlation between adult natural mortality rates of caribou and calf recruitment.....11

Figure 10. Spring (late-winter) calf:cow ratios for the Bathurst herd 1985-2014.....11

Figure 11. Fall bull:cow ratios in the Bathurst herd 2004-2012.....13

Figure 12. NWT barren-ground caribou management zones in the main Bathurst caribou winter range and adjacent areas.....15

Figure 13. An example of winter harvest mapped for North Slave communities and caribou management zones and a summary of harvest estimates for the Bathurst herd 2007-2013.....16

Figure 14. Composite maps of collared caribou locations of Bluenose-East (green) and Bathurst (red) caribou during winter (December-April) of 2010-2014 in relation to NWT barren-ground caribou management zones.....18

Figure 15. Movements of collared Bathurst (green) and Bluenose-East (red) caribou in winter 2013 (December 2012-April 2013) in relation to caribou management zones and main harvest areas.....20

Figure 16. Wolf den reconnaissance survey in Bathurst summer range in 2012.....21

Figure 17. Observed (a) number of active dens and (b) pup recruitment (±SE) during annual aerial surveys (1996-2012) and repeated aerial/ground based surveys of tracked individual packs (2013-2014) on the summer range of the Bathurst herd, NWT and Nunavut.....23

Figure 18. Far-ranging movements of satellite collared wolves captured in the Bathurst den survey area October-December 2013.....23

Figure 19. Rates of switching between calving grounds of collared caribou cows from four neighbouring herds where at least two consecutive June locations were known, 2010-2014.....26

Figure 20. Population estimates from surveys of the Bluenose-East caribou herd 2000-2013.....29

Figure 21. Estimates of adult caribou (1-year-old+) on the Bluenose-East herd's calving grounds in 2010, 2013 and 2014 from calving photo surveys and reconnaissance surveys.....31

Figure 22. Flight lines and collared caribou locations (cows red, bulls blue) from June 5-7, 2014 calving reconnaissance survey over Bluenose-East calving grounds.....32

Figure 23. Spring calf:cow ratios for the Bluenose-East herd 2008-2014 (no survey in 2013 because herds were mixed).....33

Figure 24. Back fat thickness in hunter-killed Bluenose-East caribou cows during winters 2010-2014 as collected by Tłı̨chǫ hunters during community hunts.....36

Figure 25. Barren-ground caribou management zones in the NWT (mostly North Slave Region) and estimates of harvest from the Bluenose-East herd 2009-2013.....36

Figure 26. Relative abundance of caribou on traditional Bathurst migratory ranges inferred from spruce root scars 1900-2000, from Tłı̨chǫ (Dogrib) elders (1920s-1980s), and from biologists' surveys (1980s-2000s).....40

Figure 27. Relative abundance of the Bathurst caribou herd in NWT/Nunavut and of the George River herd in Quebec/Labrador 1985-2014.....41

Figure 28. Re-constructed relative abundance of the George River caribou herd 1750-2000 based on spruce root scarring. 42

Figure 29. Estimated size of the Fortymile caribou herd 1940-1990.....43

Figure 30. Fire map showing burned areas from recent decades in the NWT in the region surrounding Great Slave Lake.....45

Figure 31. Population trend and harvest reduction in the Cape Bathurst, Bluenose-West and Bathurst herds 2000-2012.....46

LIST OF TABLES

Table 1. Pregnancy rates of Bathurst caribou cows 1990-2014 recorded either from hunter-killed animals or from blood samples of caribou captured for collar deployment.....14

Table 2. Pregnancy rates in 138 caribou cows captured March/April 2012 during collar deployments for herds across the NWT.....14

Table 3. Numbers of collared caribou locations, percentages of collar locations, and numbers of collared caribou occurring in or near NWT game management zones R/BC/01, R/BC/02, R/BC/03, S/BC/03 and U/BC/01 in winters 2010-2014.....19

Table 4. Wolf Carcass/Skull Collection in the North Slave Region 2009-2014.....25

Table 5. Pregnancy rates of Bluenose-East caribou cows 2010-2014 recorded either from hunter-killed animals or from blood samples of caribou captured for collar deployment...34

Table 6: Potential reasons for decline in estimates of Bathurst herd in 2014.....50

Table 7: Potential reasons for decline in estimates of the Bluenose-East herd in 2014.....54

INTRODUCTION

In the Northwest Territories (NWT), all migratory barren-ground caribou herds monitored by the Government of the Northwest Territories Department of Environment and Natural Resources (ENR) declined substantially between 2000 and 2006-2009 (Adamczewski et al. 2009 In Prep). As a result of these declines, monitoring of the herds was increased and management actions were taken to address declines. Population surveys have been carried out every three years; in addition, other monitoring has been carried out to better understand the conditions each herd is facing.

One of the monitoring surveys that ENR has used is a calving ground reconnaissance survey in June near the peak of calving. These surveys are flown by small fixed-wing aircraft at a fixed elevation above ground with two observers on each side. Numbers and types of caribou seen are recorded in a strip 400 m wide on each side of the plane. The results are used to map the calving grounds and to provide an indicator of the numbers of caribou at least one year old on the calving ground, most of which will be breeding cows (cows with calves or cows about to calve). Estimates of caribou numbers from these surveys do not provide precise population estimates as the ground coverage is low and the variance on the estimates is large. However, these surveys have to date reliably tracked population trend when compared to more intensive calving ground photo surveys flown at three-year intervals.

In June 2014, reconnaissance surveys were flown over the calving grounds of the Bathurst and Bluenose-East caribou herds (Figure 1, 2) using methods consistent with previous similar surveys. In the Bluenose-East herd, survey results indicated that the rapid decline documented 2010-2013 from calving ground photo surveys has continued and may have accelerated. In the Bathurst herd, previous June surveys had indicated a stable trend 2009-2012, but the June 2014 results suggested a large decline since 2012. Results of these surveys, in combination with other monitoring information, were considered serious enough to set up a meeting August 27, 2014 in Yellowknife, NWT with Aboriginal leaders

and co-management boards to review the information and discuss what management actions should be considered. In response to comments and questions at that meeting, further meetings and more detailed review of information were planned for October 2014, along with further meetings of leaders and boards in November.

The purpose of this document is to provide an overview of technical information on the two herds up to fall 2014, mostly gathered by ENR, with the emphasis on 2009-2014. Results of monitoring are summarized with interpretation of trends. Two main sections describe monitoring and management of the Bathurst and Bluenose-East herds. A summary on cyclical changes in caribou herds over time and on the demographic indicators of decline in caribou follows. The overview concludes with an assessment of the two herds' trend to fall 2014 and the likeliest explanations for the June 2014 survey results. This document is not an exhaustive analysis of these subjects, but references listed and other reports and papers provide greater detail.

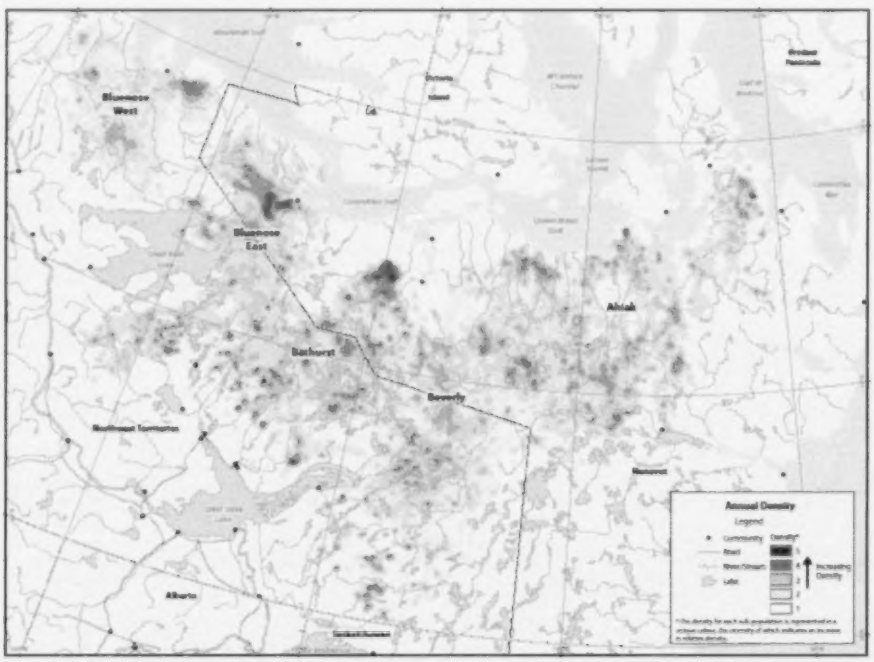


Figure 1. Bathurst, Bluenose-East and neighbouring caribou herds annual ranges based on collar locations 2006-2012. Darker areas were used more heavily than lighter more peripheral areas. Calving grounds are at the north end of the annual ranges.

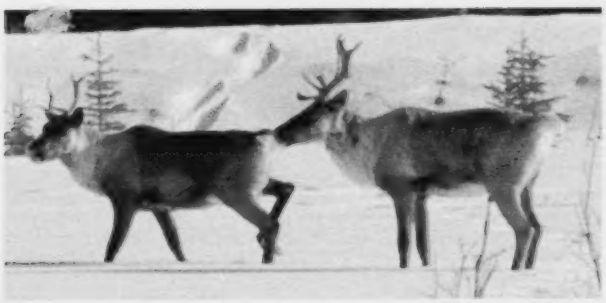


Figure 2. Female and male caribou. (Photo: GNWT/J. Adamczewski, ENR)

BATHURST HERD

Population Surveys

Calving ground photo surveys have been used since the 1980s to estimate the numbers of breeding females in the Bathurst herd in June (Figure 3). These estimates have been extrapolated to estimates of adult caribou (1.5 year-old or older) using measures of herd-wide pregnancy rate and sex ratio to account for non-pregnant cows and bulls, many of which will not be on the calving ground. Methods used in these surveys were described by Boulanger et al. (2014a) for the June 2012 Bathurst survey. Figure 3 shows the seven estimates of breeding females and extrapolated herd estimates from calving ground photo surveys of the Bathurst herd 1986-2012. The herd numbered nearly 500,000 in 1986, and then declined slowly through the 1990s and more rapidly in the 2000s. The most rapid decline occurred between 2006 and 2009 when the estimate of breeding females declined from about 55,600 to 15,900, with a similar trend in overall herd size. From 2009-2012 the herd showed a stable trend of 32,000-35,000 adult caribou. A further calving ground photo survey is planned for June 2015.

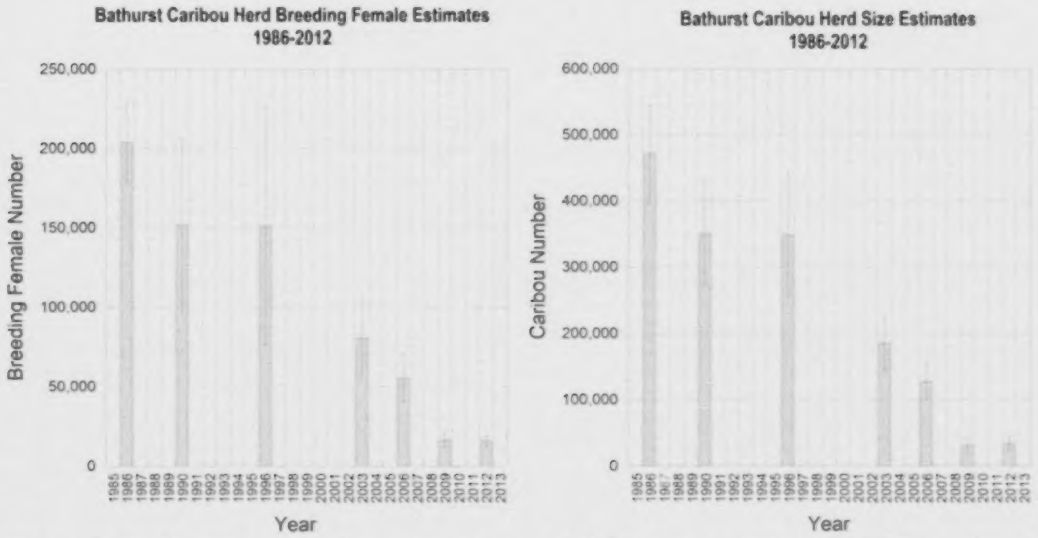


Figure 3. Estimates of breeding female and adult caribou (1.5-year-old+) in the Bathurst herd 1986-2012.

Calving Ground Reconnaissance Surveys

Reconnaissance surveys on the calving grounds are less intensive and much less expensive than calving ground photo surveys. They provide information on where a herd's calving grounds are that year, and they provide an indicator of the numbers of caribou at least one year old on the calving ground; a high proportion of these adults are usually breeding females. The surveys are flown in June near the peak of calving using small planes that fly lines spaced five or ten kilometres apart. These surveys are not designed to provide a precise population estimate, but when flown consistently and repeated over time, they can give an index of trend in the numbers of caribou on the calving ground. Methods and results of a June 2014 calving ground reconnaissance survey for the Bathurst herd are described by Boulanger et al. (2014b) along with results from previous similar surveys beginning in 2006. Figure 4 shows the trend in numbers of 1-year-old or older caribou found on the calving grounds 2006-2014 for the Bathurst herd (note the 2011 survey was unsuccessful).

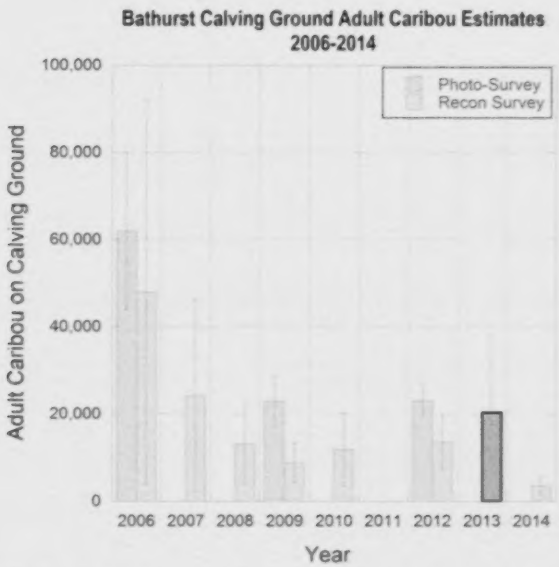


Figure 4. Trend in numbers of caribou at 1-year-old or older on the Bathurst calving grounds 2006-2014.

Figure 4 also includes the estimates of 1-year-old or older (adult) caribou on the Bathurst calving grounds derived from the calving ground photo surveys in 2006, 2009 and 2012. Reconnaissance surveys are the initial phase of calving ground photo surveys and are

followed by more intensive photo surveys of higher-density blocks and visual surveys of lower-density blocks. The higher numbers from the photo surveys reflect the more complete counts of larger groups in higher-density areas from photos, compared to initial visual counts completed during reconnaissance flying. Overall, results of the reconnaissance surveys paralleled results of the photo surveys between 2006 and 2009 and between 2009 and 2012. Numbers of adult caribou from the reconnaissance surveys declined rapidly 2006-2009, and then showed a stable trend 2009-2012, in parallel to the numbers of adults estimated on the photo survey.

A reconnaissance survey was flown June 9, 2013 (at the end of the June 2013 Bluenose-East calving photo survey) but occurred just after a snow-storm (Figure 5). Observers' ability to sight caribou was poor. Very low numbers of caribou were seen (95 in total on transect) but this was thought in large part due to the ground conditions. The survey was suspended after the main calving area had been flown. A second reconnaissance survey was carried out on June 13, 2013 after the snow melted but it was well past the peak of calving and larger groups seen may have reflected initial post-calving aggregation. Estimates from June 13, 2013 are included in Figure 3 but may have been inflated by a few of these larger groups, which can include non-breeding cows, yearlings and bulls. Results of both recon flights in June 2013 should be considered with caution.

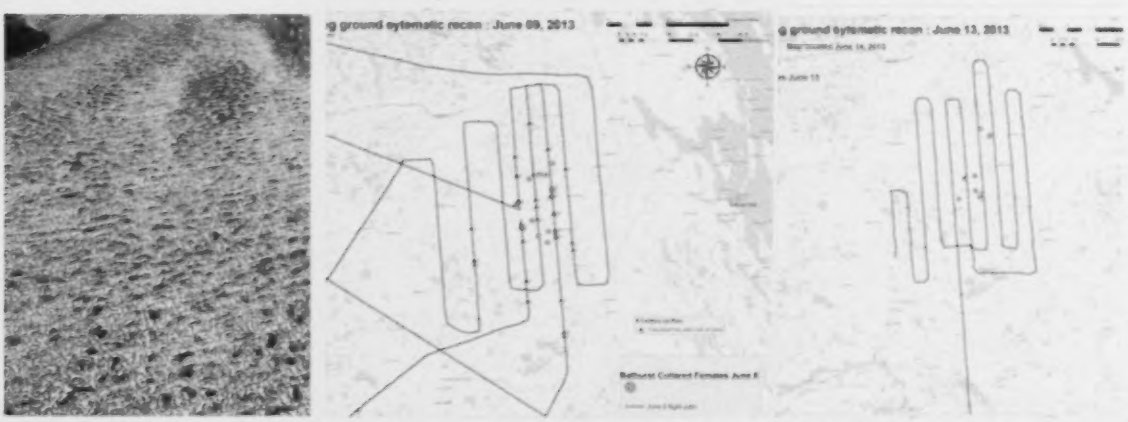


Figure 5. Snow cover on the Bathurst calving ground June 9, 2013 (left), reconnaissance lines flown that day (middle) and reconnaissance lines flown June 13, 2013 (right). Green dots are collared cow locations and red triangles are locations of caribou groups seen.

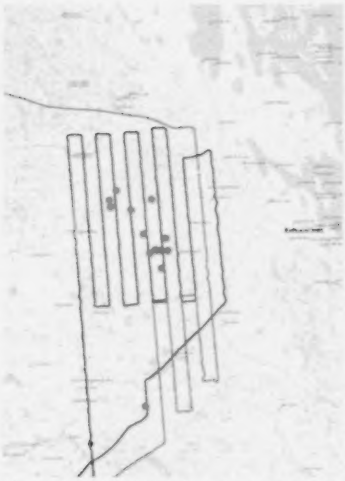


Figure 6. Flight lines flown on June 8-9 2014 reconnaissance survey of Bathurst calving ground.

Results of the June 2014 Bathurst reconnaissance survey were described by Boulanger et al. (2014b) and included in Figure 3. Weather and visibility were excellent, similar to 2012. Results of this survey suggest the Bathurst has declined since 2012. Because of the limited coverage and large variance on reconnaissance surveys, the results should be treated with caution. The 2012 recon survey resulted in an estimate of 14,390±6,109 adults 1-year-old or older on the calving ground, while the 2014 reconnaissance survey resulted in an estimate of 3,594±2,133 adults. Of 18 satellite collared Bathurst caribou in June 2014, 17 were within the survey area (Figure 5), suggesting that a high proportion of the herd's cows were on the calving ground.

Monitoring from 1996-2014 has shown that female caribou have consistently used the same general area southeast of Bathurst Inlet for calving (e.g. Boulanger et al. 2014a). The Bathurst herd appears to have continued to maintain a single concentrated calving area even at lower numbers (Figures 6, 7), presumably to maintain the advantages of gregarious calving (Bergerud et al. 2008, Griffith et al. 2002).

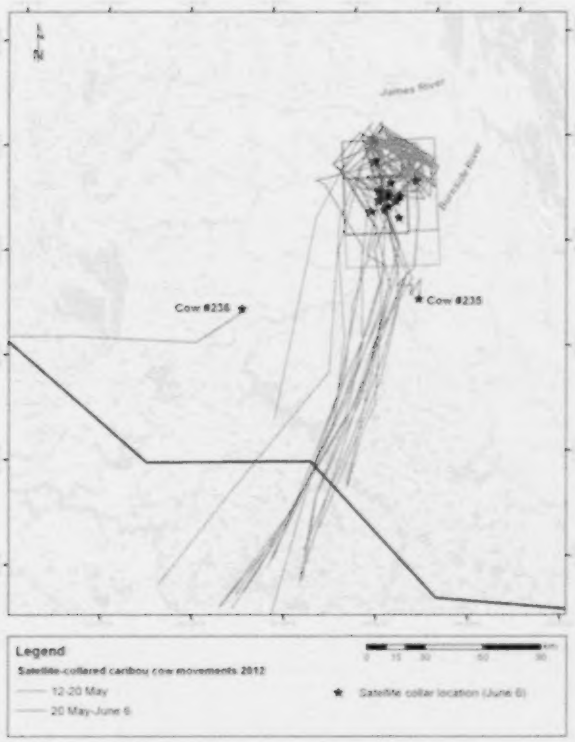


Figure 7. Movements of collared caribou to the Bathurst calving ground area, May 12 to June 6, 2012. Locations from May 12-20 are shown as blue lines and locations from May 21 - June 6 are given as red lines. The location of caribou during the photo survey on June 6 is noted. (Boulanger et al. 2014b).

Adult Cow Survival Estimates

Survival of adult female caribou is a key demographic variable for caribou herds, although it is difficult to measure. Stability of caribou herds is more closely tied to survival rates of cows than to other demographic variables (Fancy et al. 1994, Boulanger et al. 2011). Figure 8 shows estimates of cow mortality rate compared to population rate of change based on caribou herds in Alaska, NWT and Quebec.

Overall, stable herds had cow mortality rates of 17% or less (survival of 83% or higher). Population modeling for the Bathurst herd has similarly suggested that cow survival rates of about 86% are needed for a stable herd (Boulanger et al. 2011). Estimation of cow survival rates has been carried out from collared cows in herds where collar numbers are adequate (e.g. 100 collared cows in western Arctic and Porcupine herds) but has been

difficult for the Bathurst herd, given that numbers of collars have averaged less than 20 at any given time and have sometimes been fewer than ten. Cow survival has been estimated instead from a population model that uses all demographic information for the herd (Boulanger et al. 2011, 2014a). Analysis by Boulanger et al. (2011, 2014a) provided cow survival estimates for the Bathurst herd of 86% in 1985, 73% in 2007-2008, 67% in 2009 and 78-79% in 2009-2012. This suggested that cow survival had increased from the period of rapid decline in the Bathurst herd up to 2009, but might still be marginal 2009-2012 despite a stable herd trend 2009-2012 (Boulanger et al. 2014a).

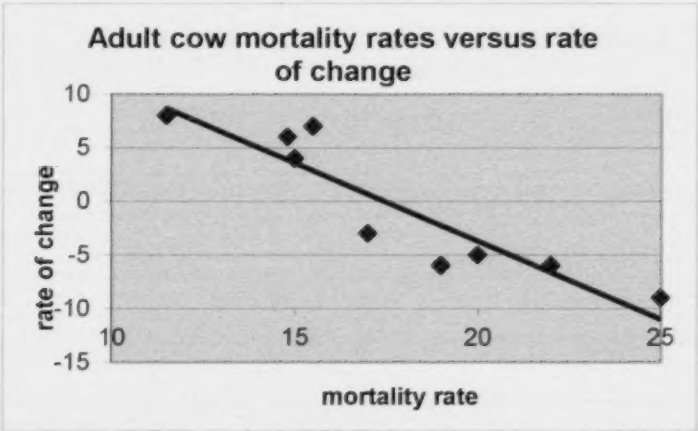


Figure 8. Adult cow caribou mortality rate compared to population rate of change in barren-ground caribou herds (courtesy of D. Russell, CARMA, pers. comm. 2009).

Spring Calf Recruitment Surveys

Spring calf recruitment surveys have been carried out frequently for the Bathurst herd since 1985. The key result from these surveys is a calf:cow ratio that provides an index of the proportion of the previous year's calves that survived to about ten months of age. Mortality of calves in their first six months is often high, while calves that reach a year of age generally survive at rates similar to adults. Caution is needed in interpreting calf:cow ratios, as they can be affected by the survival rate of calves (numerator) as well as the survival rate of cows (denominator). In general, sustained calf:cow ratios of <20 calves:100 cows are clearly indicative of a declining natural trend in the herd. Ratios of 35-40:100 or higher usually indicate a herd likely stable and possibly increasing; however, the proportion of calves needed for a stable herd depends in part on adult female survival

rates. In the George River herd, if adult and yearling female survival was 80%, then a fall calf:cow ratio of 52:100 was needed for a stable herd, while fall calf:cow ratios of 39:100 was needed for a stable herd if adult and yearling female survival was at 85% (Crête et al. 1996). Boulanger et al. (2011) reached similar conclusions. At cow survival estimates of 67% (Bathurst herd in 2009), the herd could not produce enough calves to achieve stability (Boulanger et al. 2011).

Calf recruitment and natural survival rates of adults show a correlation (with substantial variance) that suggests that environmental conditions favouring good calf survival also generally favour good natural adult survival (Figure 9, adapted from Bergerud 2000). Reduced spring calf:cow ratios may thus be indicators of concurrent reduced natural survival among adult caribou.

Spring calf:cow ratios for the Bathurst herd between 1985 and 2014 are shown in Figure 10. In general, calf:cow ratios were consistently above 30:100 and frequently exceeded 40:100 from 1985-1995. From 2000-2006, calf:cow ratios declined from 29:100 to a low of 9:100 in 2006. Over this period, the herd had a declining natural trend, and a rapid decline based on calving photo surveys and calving ground reconnaissance surveys. Higher ratios of 37-49:100 were recorded 2007-2011, over a period when the herd began to stabilize. Ratios in 2007, 2008 and 2009 may have been inflated by high cow mortality before the Bathurst harvest was substantially restricted in 2010.

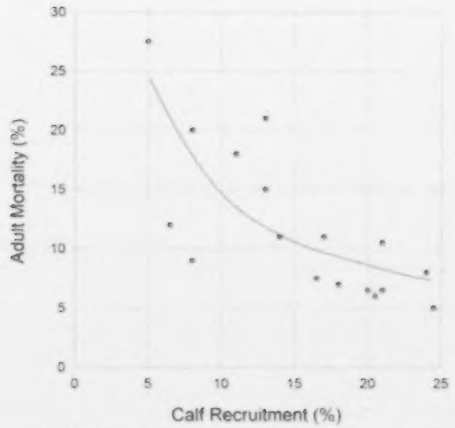


Figure 9. Correlation between adult natural mortality rates of caribou and calf recruitment. (Adapted from Bergerud. 2000.)

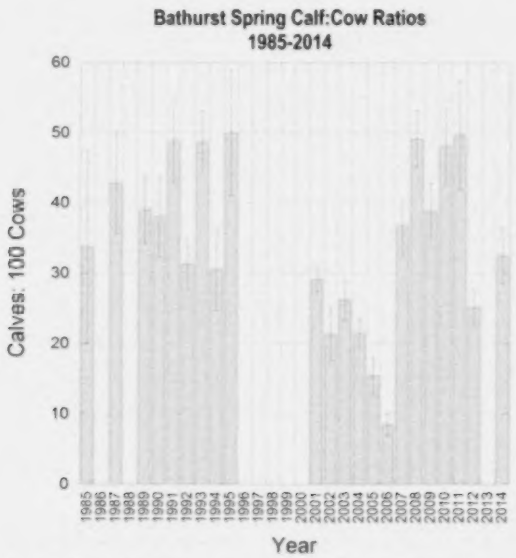


Figure 10. Spring (late-winter) calf:cow ratios for the Bathurst herd 1985-2014.

The most recent Bathurst spring calf:cow ratios were 25:100 in 2012 and 32:100 in 2014. These were somewhat lower than the ratios recorded 2007-2011. A spring composition survey was not carried out in 2013 due to substantial mixing of Bathurst and Bluenose-East caribou. However, a fall composition survey was carried out for the Bathurst herd in October 2012 (calves born 2012); the calf:cow ratio was 24:100. Fall calf-cow ratios (calves five months old) are generally similar and usually slightly higher than spring ratios (calves ten months old). This would indicate consistently lower calf recruitment 2012-2014

(calves born in 2011, 2012 and 2013) than in 2010 and 2011 (calves born 2009 and 2010) in the Bathurst herd.

Fall Composition Surveys

Fall composition surveys have been conducted periodically for the Bathurst herd. The main focus of these surveys is to provide an estimate of sex ratio (bulls:100 cows) in the herd.

The surveys are carried out in mid-late October near the peak of the breeding season or rut. At this time of year, with adequate spatial coverage, all segments of the herd are mixed and the male:female ratio can be estimated reliably. At other times of year, cows with calves are usually segregated (found in different areas) from bulls, yearlings and non-breeding cows. Figure 11 shows fall bull:cow ratios for the Bathurst herd from 2004 to 2012. Bull:cow ratios between 2004 and 2008 ranged between 31 and 38 bulls:100 cows, and were higher in 2011 and 2012 at 56-58 bulls:100 cows. Bull:cow ratios in barren-ground caribou are biased towards females, as males have higher mortality rates than females at all ages and ratios of about 50:100 are common (Bergerud 2000). Ratios below 50:100 are consistent with herds experiencing poor conditions, as demonstrated for the Bathurst herd by the low bull:cow ratios in this herd 2000-2006. Increased bull:cow ratios in 2011 and 2012 appear consistent with the herd's stabilizing trend 2009-2012. As with calf:cow ratios, however, bull:cow ratios are influenced by mortality rates of both bulls and cows; high cow mortality can inflate bull:cow ratios. This may in large part account for the apparently high bull:cow ratios in 2011 and 2012 (discussed further by Boulanger et al. 2014a).

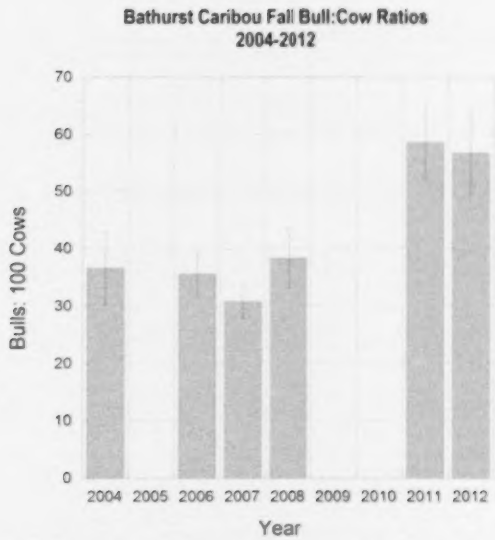


Figure 11. Fall bull:cow ratios in the Bathurst herd 2004-2012.

Pregnancy Rates

Information on pregnancy rates of Bathurst caribou cows has been collected periodically since 1990 from hunter-killed cows in the winter, but in many of the years the sample size has been small (ten to 15 cows or less). The low sample sizes make it difficult to consider these rates as reliably representing the herd's average pregnancy rate. In some years, pregnancy rates of Bathurst cows have also been determined in cows captured in March/April and tested for progesterone in the serum (high in pregnant cows and very low in non-pregnant cows). The results are listed in Table 1. In most years, pregnancy rates have been relatively high (80% or more). A year that stood out for both an adequate sample size (n=150) and a low pregnancy rate (63%) was 2005; this was a year during a period (2000-2006) when Bathurst calf recruitment was consistently low (nine to 20 calves: 100 cows) and the herd was declining rapidly. In 1994, by contrast, 107 of 116 (92%) hunter-killed Bathurst cows were pregnant; these contrasting rates illustrate the range of pregnancy rates that have been documented in the herd.

Table 1. Pregnancy rates of Bathurst caribou cows 1990-2014 recorded either from hunter-killed animals or from blood samples of caribou captured for collar deployment.

Date	Hunter kits/Collections	Collaring	Combined
March 2014	n/a	9/13	
March 2013	Adult cows 5/5 (100%)		
March 2012	n/a	13/14	
February 2011	Adult cows 20/25 (80%)	12/14	32/39 (82.0%)
March 2010	Adult cows 10/14 (71.4%)	12/14	22/28 (78.6%)
April 2009	Adult cows 25/28 (89.3%)		
March 2008	Adult cows 26/26 (100%)		
March 2005	Adult cows 95/150 (63.3%)		
March 1995	Adult cows 10/13 (76.9%)		
March 1994	Adult cows 107/116 (92.2%)		
March 1992	Adult cows 11/14 (78.6%)		
March 1991	Adult cows 6/10 (60%)		
March 1990	Adult cows 10/10 (100%)		

Table 2. Pregnancy rates in 138 caribou cows captured March/April 2012 during collar deployments for herds across the NWT.

Herd	Blood collected (females)	# Pregnant	Pregnancy Rate
Bathurst	13	12	92.3
Bluenose-East	42	27	64.3
Beverly/Ahiak	27	16	59.3
Bluenose-West	34	17	50.0
Cape Bathurst	12	7	58.3
Tuktoyaktuk Peninsula	10	5	50.0
Totals	**138**	**84**	**60.9**

An NWT-wide collar deployment across multiple herds in March/April 2012 resulted in pregnancy being tested from serum progesterone in 138 cows at capture. The overall pregnancy rate was 60.9% (84/139), similar to the 63% recorded in Bathurst cows in 2005 during a period of rapid decline in the herd. For Bathurst cows, 12 of 13 captured females were pregnant in 2012 but this is a small sample. Because the low pregnancy rate applied across several herds on a large scale in 2012, this may be indicative of a range-wide effect

mediated by weather resulting in poor summer range condition leading to many cows being lean in the fall breeding season (Cameron et al. 1993, Cameron 1994).

Harvest Estimates

Hunter harvest from the Bathurst herd has not been monitored reliably in all years. The harvest was estimated at 4,000-6,000/year, mostly cows, in 2007-2008 and 2008-2009, based on check-station results, hunter interviews and officer patrols carried out by ENR North Slave wildlife staff (Adamczewski et al. 2009 In Prep). This estimate included 419 and 223 bulls taken in 2008 and 2009 by outfitter clients, less than 100 bulls taken annually by resident hunters, and an estimated 4,000-5,000 taken by Aboriginal hunters, primarily cows on the winter range. There is a limited harvest in Nunavut by Aboriginal hunters and outfitters.

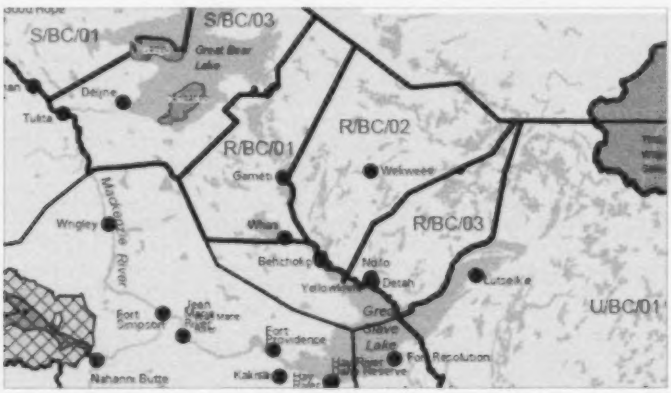
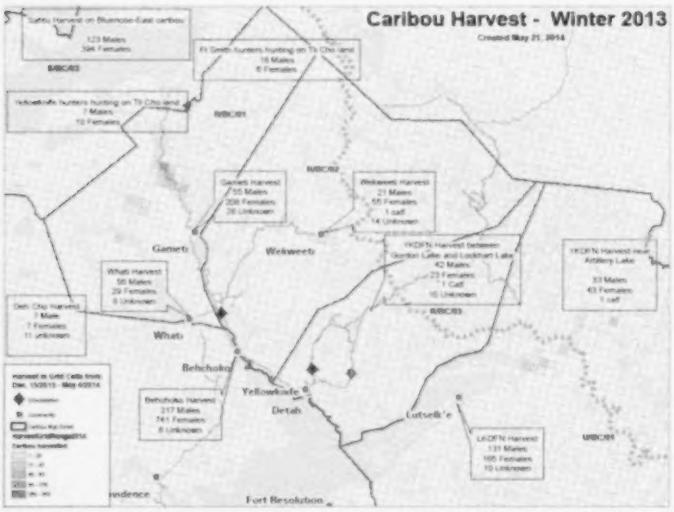


Figure 12. NWT barren-ground caribou management zones in the main Bathurst caribou winter range and adjacent areas.

Resident and outfitter harvest was closed at the end of 2009 in the NWT and Aboriginal harvest restricted to 300 or less (80% bulls or 60 or less cows), by agreement with the Tłı̨chǫ government and the Yellowknives Dene First Nation in 2010. The restricted harvest applied in two management zones (R/BC/02 and R/BC/03) created to include the main NWT Bathurst winter range (Figure 12).

Since the major harvest restrictions on the Bathurst herd in 2010, harvest in the North Slave region (primarily zones U/BC/01, R/BC/01, R/BC/02 and R/BC/03) has been

monitored by a combination of check-stations, community monitors, officer patrols and estimates of community harvest from wildlife officers (Nunavut). Locations of harvested caribou are mapped and assigned to herd based on zones and collared cow locations. An example of mapped harvest from winter 2013 is shown in Figure 13, along with a summary of estimated harvest before 2010 and Bathurst harvest as reported for R/BC/02 and R/BC/03 from 2010-2013. Harvest reported for R/BC/02 and R/BC/03 has averaged 191 caribou with a variable sex ratio. These estimates are considered under-reported; they do not include harvest in Nunavut, wounding losses or harvest of Bathurst caribou in zones outside R/BC/02 and R/BC/03.



Bathurst Harvest Estimates

2007-2009:
4000-6000/year, mostly cows

2009-2013*:
Monitors, officers, check-stations

Year	Estimated	% cows
2009-2010	300	65
2010-2011	213	58
2011-2012	87	82
2012-2013	166	42
Average	191	62

* As reported for RBC02 and RBC03; total harvest may be under-reported

Figure 13. An example of winter harvest mapped for North Slave communities and caribou management zones (left) and a summary of harvest estimates for the Bathurst herd 2007-2013 (right). Sex ratio of a portion of the reported harvest was reported as unknown; table includes sex ratio for caribou where it was reported.

To assess the likelihood and potential extent of harvest of Bathurst caribou outside the two zones where caribou harvest is limited to 300 or less (R/BC/02 and R/BC/03), winter collar locations of Bathurst and Bluenose-East caribou were mapped for each winter (December-April) from 2010-2014 (Figure 14). In addition, the numbers of collar locations, the percentages of collar locations, and the numbers of individual collared caribou from the two herds found in each of five management zones were tabulated (Table 3).

In general, Bluenose-East caribou were primarily found in R/BC/01 and S/BC/03, south, east and north of Great Bear Lake, but were also found in R/BC/02 in four of the five winters. Bathurst collared caribou wintered mostly in R/BC/02 and R/BC/03, but 8, 14, 12, 24 and 0% of the collared caribou locations were in R/BC/01 in 2010, 2011, 2012, 2013, and 2014, respectively. Bathurst collared caribou also were found in U/BC/01 to a limited extent in 2012 and 2013; in 2013, 13% of the Bathurst collar locations were in U/BC/01.

Bathurst caribou wintering outside of R/BC/02 and R/BC/03 could have been exposed to additional harvest in R/BC/01 and to a lesser extent in U/BC/01. Most of the estimated/reported Bluenose-East harvest since 2010 has been in R/BC/01, with average harvest estimated at about 2,700/year, mostly cows. However, as noted further on in this summary, this estimate is considered under-reported and may be 4,000 or more. The relative sizes of the two herds (Bathurst smaller than Bluenose-East) and the predominance of use of R/BC/01 and S/BC/03 by Bluenose-East caribou would suggest that most of the caribou harvest in R/BC/01 has been from the Bluenose-East herd. Defining the Bathurst herd's winter distribution has been challenging due to the low collar numbers on this herd; there have generally been more collars on Bluenose-East caribou. If a substantial part of the Bathurst herd wintered in R/BC/01 where harvest of several thousand caribou is estimated to have occurred, then some of this harvest was likely Bathurst caribou (e.g. in 2013 in the Hottah Lake area southeast of Great Bear Lake (Figure 15).

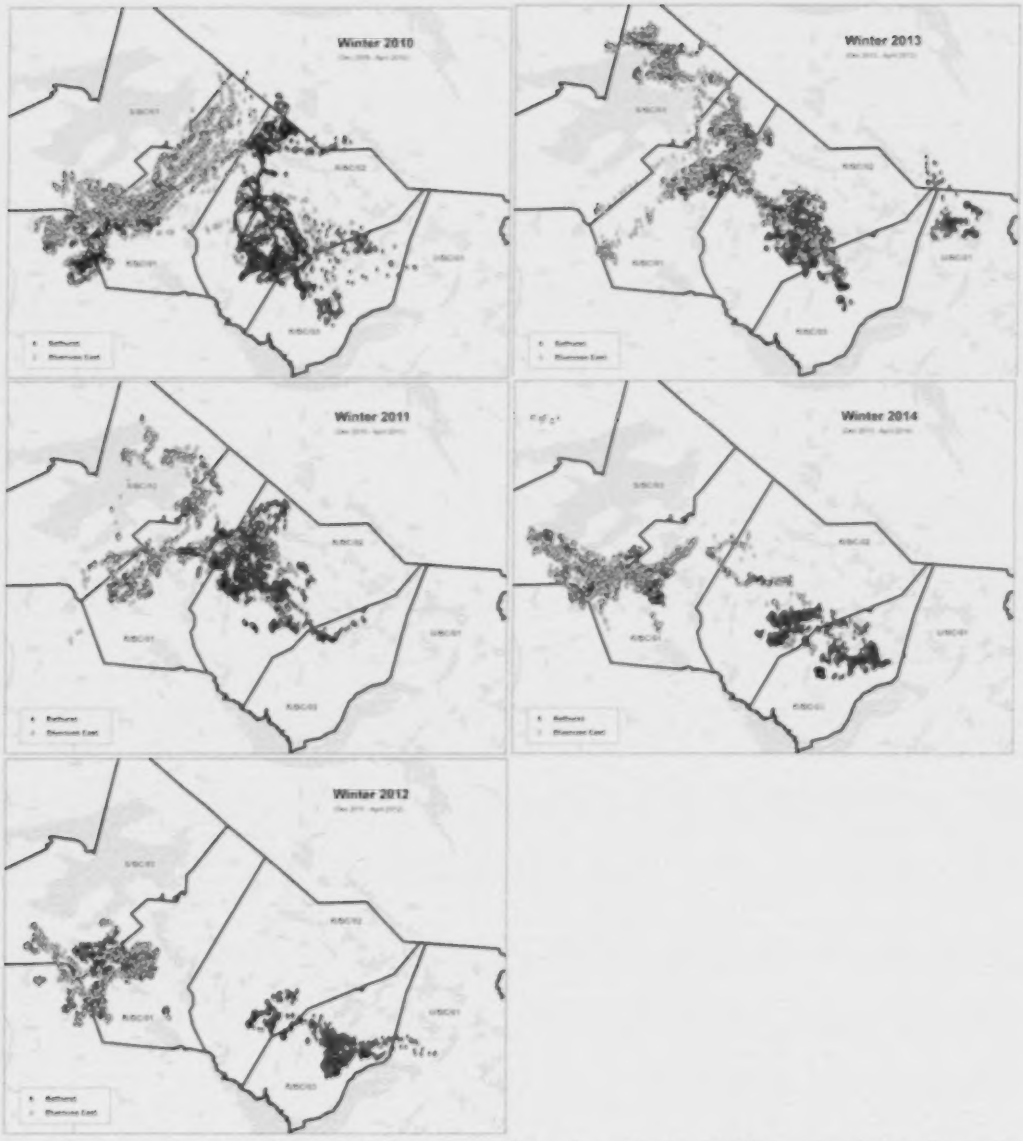


Figure 14. Composite maps of collared caribou locations of Bluenose-East (green) and Bathurst (red) caribou during winter (December-April) of 2010-2014 in relation to NWT barren-ground caribou management zones. R/BC/02 and R/BC/03 are the zones where Bathurst caribou harvest has been limited to 300 or less since January 2010.

Table 3. Numbers of collared caribou locations, percentages of collar locations, and numbers of collared caribou occurring in or near NWT game management zones R/BC/01, R/BC/02, R/BC/03, S/BC/03 and U/BC/01 in winters 2010-2014. These numbers apply to the maps in Figure 14.

WINTER 2010

BATHURST

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	5647	464	4387	556	0	4	236
% POINTS		0.08	0.78	0.10	0.00	0.00	0.04
# COLLARS	26	3	17	15	0	1	2

BLUENOSE EAST

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	9842	4111	1836	68	1008	0	2819
% POINTS		0.42	0.19	0.01	0.10	0.00	0.29
# COLLARS	56	46	15	4	22	0	25

WINTER 2011

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	3782	548	3046	188	0	0	0
% POINTS		0.14	0.81	0.05	0.00	0.00	0.00
# COLLARS	21	9	21	1			

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	7738	3652	2718	0	1364	0	4
% POINTS		0.47	0.35	0.00	0.18	0.00	0.00
# COLLARS	35	23	15		15		1

WINTER 2012

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	1870	216	382	1145	102	25	0
% POINTS		0.12	0.20	0.61	0.00	0.01	0.00
# COLLARS	25	4	8	15	1	6	

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	5829	3793	0	10	894	0	1132
% POINTS		0.65	0.00	0.00	0.15	0.00	0.19
# COLLARS	68	60		1	17		10

WINTER 2013

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	2114	501	942	369	0	272	30
% POINTS		0.24	0.45	0.17	0.00	0.13	0.01
# COLLARS	20	7	13	6		2	2

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	9494	3258	1473	119	4582	0	62
% POINTS		0.34	0.16	0.01	0.48	0.00	0.01
# COLLARS	51	28	22	3	25		3

WINTER 2014

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	1582	0	887	694	0	1	0
% POINTS		0.00	0.56	0.44	0.00	0.00	0.00
# COLLARS	23		17	12		1	

	TOTAL	HUNTING ZONES R/BC/01	R/BC/02	R/BC/03	S/BC/03	U/BC/01	OUT
LOCATIONS	7142	3715	457	26	2544	0	400
% POINTS		0.52	0.06	0.00	0.36	0.00	0.06
# COLLARS	40	31	5	1	22		4

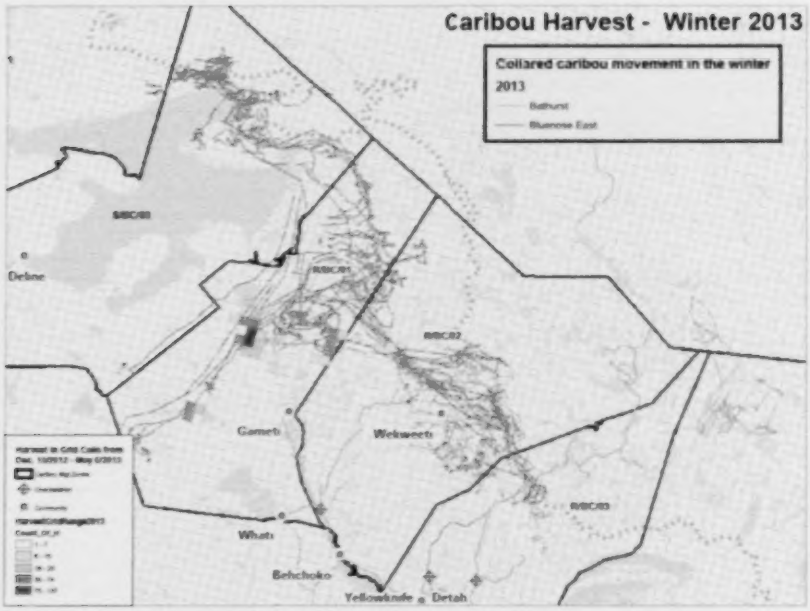


Figure 15. Movements of collared Bathurst (green) and Bluenose-East (red) caribou in winter 2013 (December 2012-April 2013) in relation to caribou management zones and main harvest areas. Squares are 10x10 km, coloured squares show areas where harvest was recorded and darker colours show areas with greater levels of harvest.

Wolf Monitoring and Harvest

Trends in the number of wolves in the NWT are of management interest because wolves are the main predator of barren-ground caribou. However, wolves are difficult to count at the population scale and high costs and potential biases inherent in existing techniques have limited efforts. Wolves on the tundra follow barren-ground caribou as caribou migrate from summer ranges on the tundra to winter ranges typically in the boreal forest. Counting wolves in forested areas is problematic because of trees, and therefore wolves may be better counted on the tundra where they are more easily observed. Wolves on the tundra raise their pups in dens, which are visible from the air. Wolves tend to re-use their den site each year and therefore annual surveys of den use (occupancy) over a wide area can provide a technique to monitor annual changes in wolf abundance and productivity.

Wolf numbers in the Bathurst summer range have been monitored by annual den surveys since 1996. Prior to 2006, different study objectives involving radio collared wolves restricted the survey area covered. From 2006-2012, sampling coverage increased to

establish a more representative area for monitoring trends of tundra-denning wolves. An occupancy (e.g. presence/absence) approach was used with 10x10 km grid cells serving as the sampling unit. Previous research and local knowledge have shown that wolves tend to den on eskers and other gravel deposits where they can dig into the ground. Therefore, grid cells do not have to be surveyed in their entirety for wolves, but can be stratified by eskers and esker-like habitat within cells. An example of the area surveyed for wolf den occupancy is shown for summer 2012 (Figure 16).

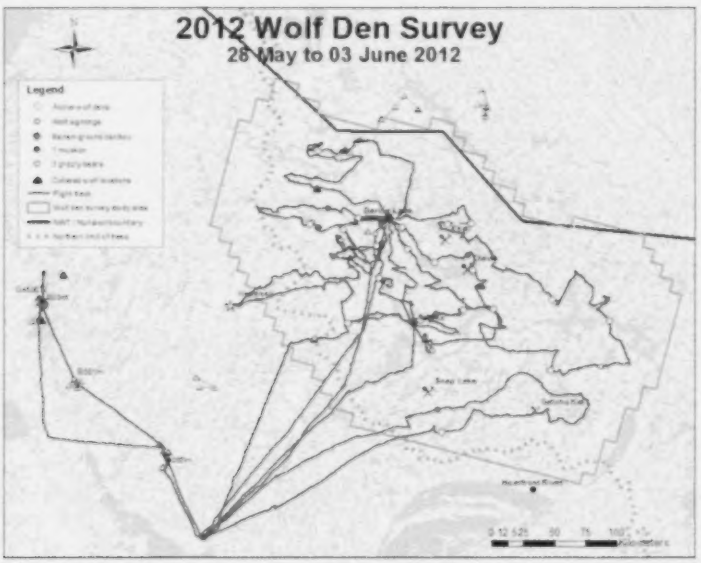


Figure 16. Wolf den reconnaissance survey in Bathurst summer range in 2012 (Map: GNWT/H.D. Cluff, ENR).

A further aerial survey in mid- to late August has been flown to all the active wolf dens found earlier that spring in each year to count the number of pups at dens. Ground observations of active dens are done in late summer where logistics permit to improve the accuracy of aerial counts. The most reliable number of wolf pups observed at each site in late summer or early fall is used to estimate recruitment of pups to the population.

Summary of NWT Wolf Project 2013/2014
(Courtesy of M. Klaczek, UNBC)

From June 21-24, 2013, 16 female wolves were captured representing individual packs; 15 were breeding (lactating) females and one was a sub-adult (non-lactating) female. Over the 2013 and 2014 denning periods, 27 wolf packs (17 and ten respectively) were monitored, 15 of which were monitored via a GPS collared adult female (N collared wolves = 15 and four in 2013 and 2014 denning periods respectively). Over five field sessions (total = 35 days; three and two sessions in 2013 and 2014 respectively), 204 aerial checks were conducted to track wolf packs by visiting known den sites, radio-tracking, or by visiting clusters of GPS locations that may have represented a relocated den or rendezvous site. Approximately 111 hours were spent observing wolf dens/rendezvous sites on the ground over 66 separate field visits.

During the 2013 denning period, six of the 15 packs with a GPS collared female lost their pups by the end of August. The mean number of pups/pack declined throughout the denning period from 2.9 (± 0.31 SE) in July, to 2.0 (± 0.40 SE) in August, and 1.7 (± 0.37 SE) in early September. Only three packs remained at their respective whelping den throughout the denning period (until early September); litter loss accounted for half of observed den abandonment. Eight active den sites (packs with pups) were located during the 2014 denning period. Only two of the four remaining GPS-collared females bred in 2014, however, wolf 432 likely lost her pups in early July, just prior to field surveys. The mean number of pups/pack declined throughout the 2014 denning period from 2.6 (± 0.6 SE) in early July to 1.8 (± 0.7 SE) in late August. Similar to 2013, only half of the monitored packs (four of eight) remained at their whelping den throughout the denning period.

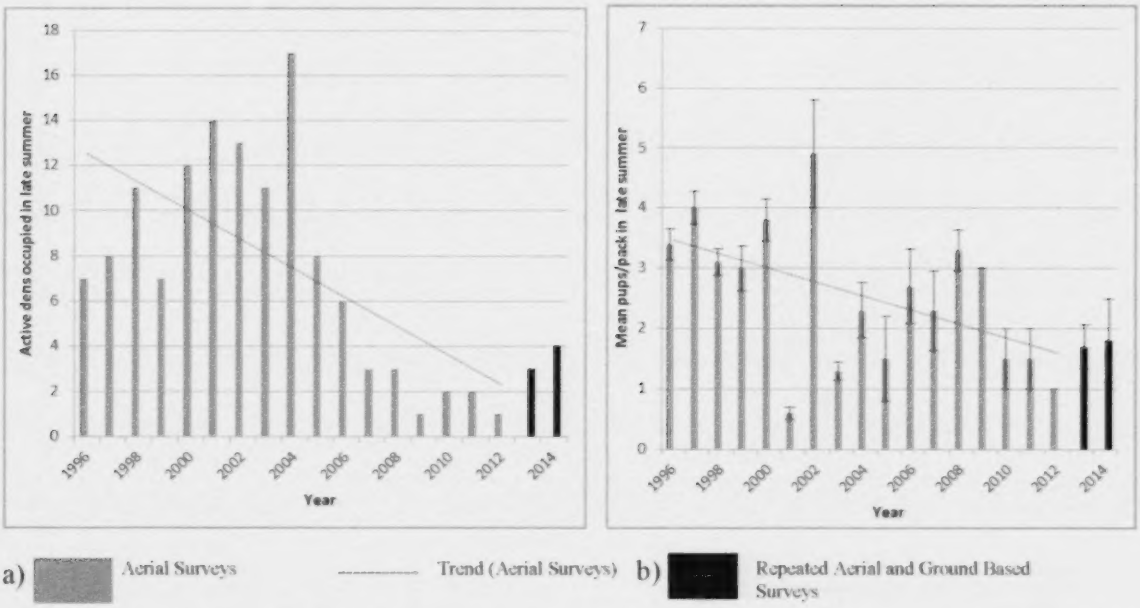


Figure 17. Observed (a) number of active dens and (b) pup recruitment (±SE) during annual aerial surveys (1996-2012) and repeated aerial/ground based surveys of tracked individual packs (2013-2014) on the summer range of the Bathurst herd, NWT and Nunavut.

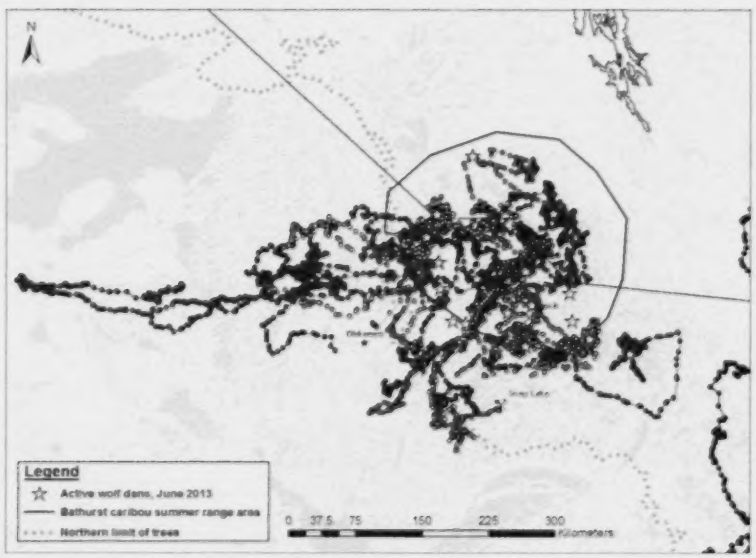


Figure 18. Far-ranging movements of satellite collared wolves captured in the Bathurst den survey area October-December 2013 (H.D. Cluff and M. Klaczek, unpublished data). Different colours identify individual wolves.

High rates of den abandonment and low pup recruitment observed during the 2013 and 2014 denning periods were consistent with observations recorded during late summer aerial surveys since 2007 (Figure 17). These results indicate that the numbers of dens occupied in late summer (Figure 17a) and annual recruitment of pups (Figure 17b) has declined 1996-2014. Our results corroborate previous observations on wolf populations in both Alaska (Boertje and Stephenson 1992) and elsewhere in North America (Keith 1983, Fuller 1989, Fuller et al. 2003) such that varying levels of ungulate biomass strongly influence wolf population dynamics. This suggests that the tundra wolf population on the Bathurst caribou range has also decreased.

Initial mapping of the movements of satellite collared wolves captured at dens in the Bathurst range in 2013 provided an indication of the far-ranging movements of these tundra wolves in the fall and early winter (Figure 18), over much larger distances than previously thought.

Wolf Harvest in the North Slave Region, 2009-2014

As part of efforts to stabilize the caribou herds and promote their recovery, a program of increased incentives for wolf harvest was initiated in 2008-09 in the North Slave Region. Initially, financial incentives were $200 for prime pelts and $100 for carcasses. Carcasses were necropsied for a variety of samples. The intent was to increase harvest of wolves on the Bathurst winter range by 80-100 wolves. Only 25 wolf carcasses were submitted in the 2008-09 season. This program continued for a second year until an NWT-wide wolf carcass collection replaced it for the 2010-11 season. At that time, financial incentives were increased to $400 for prime pelts and $200 for carcasses. These programs had limited success and it is likely that survival rates of adult and calf Bathurst caribou were not meaningfully altered. For the 2013-14 season, the North Slave Region dropped back to a skull only program and payment was $50/skull, although the $400 payment per pelt was maintained. Currently, the wolf skull collection program and pelt price incentives are continuing for the 2014-15 harvest year.

Wolf harvests have been monitored annually. The total numbers of wolf carcasses reported in the North Slave Region in 2009-10, 2010-11, 2011-12, and 2012-13 were 19, 41, 80, 56 and 25 respectively (average 44, Table 1). Of the 221 wolves harvested in total, 59 were associated with dumps or sewage lagoons, 59 were taken from areas where collared Bathurst cows have not occurred in recent years (i.e., east of Great Slave Lake in areas near Artillery Lake, Reliance and Łutselk'e), and 20 were taken in the Yellowknife area.

Table 4. Wolf Carcass/Skull Collection in the North Slave Region 2009-2014.

Location	2009-10*	2010-11	2011-12	2012-13	2013-14[a]
Dumps/Sewage Lagoons:					
Yellowknife/Dettah		2	2	6	
Łutselk'e			1		
Behchokǫ	1	3	16	13	3
Gaméti/Whatì	3				4
Wekweeti		1			4
General area/Outside of:					
Yellowknife		13	4	3	
Łutselk'e		1	6		
Behchokǫ/Hwy 3	1	3	2	8	3
Gaméti/Whatì		1			
Wekweeti			4	1	
Great Slave Lake area	3		4		
Winter Roads	4	5	7	2	9
Fort Reliance	5	1	10	6	
Artillery Lake/Sandy Lake area		9	17	4	
Grandin Lake/Hottah Lake area	1				1
Other sites within NSR			3	8	1
Outside the North Slave Region			3	1	
No location info	1	2	1	4	
TOTAL:	19	41	80	56	25

* harvest year spans 01 July to 30 June
[a] skull collection only

Movements of Collared Bathurst Caribou to other Ranges

When declines of caribou herds are detected from population surveys, a key question that is asked is whether the caribou could have moved to a neighbouring herd's range. To address this question, June locations of collared cows where there were at least two consecutive annual locations were assessed for the Bathurst and Bluenose-East herds for 2010-2014, along with their neighbours to the east and west (Figure 18). Of 149 pairs of consecutive June locations for the five herds in Figure 18, 144 (96.6%) returned to same

calving ground and five (3.3%) switched to a neighbouring calving ground. These rates of switching are consistent with previous similar low rates of collared cow movements to neighbouring ranges (e.g. Bathurst herd 2006-2009; Adamczewski et al. 2009 In Prep) and among the Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-West and Bluenose-East herds 2005-2013 (Davison et al. 2014). While the collar sample size is limited, this assessment suggests that large-scale movements of the Bathurst herd (and Bluenose-East herd) to other ranges did not occur 2010-2014.

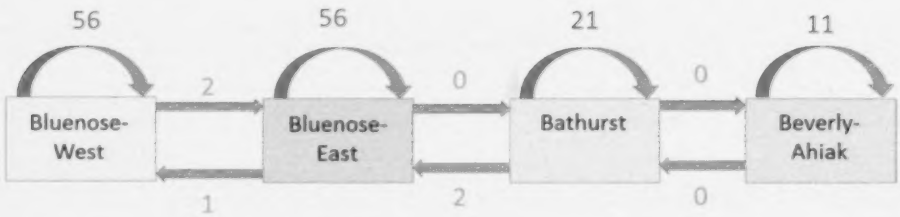


Figure 19. Rates of switching between calving grounds of collared caribou cows from four neighbouring herds where at least two consecutive June locations were known, 2010-2014. Each pair of locations represents one data point. The numbers of cases where a cow returned to the same calving ground are in blue and the cows that switched are in red.

Management Context for the Bathurst Herd

An overall management plan for the entire range of the Bathurst herd was not in place as of September 2014. However, a number of management initiatives have occurred or are underway for the herd.

Overall Bathurst Herd Management

An initial management plan for the Bathurst herd was put together through a co-management process 2000-2004 by the Bathurst Caribou Management Planning Committee and a draft plan was completed in November 2004 (BCMPC 2004). This plan was not signed off by all parties.

Since June 2012, there has been an ongoing effort by the Wek'èezhìi Renewable Resource Board (WRRB), Tłı̨chǫ Government, Government of the Northwest Territories (GNWT) and other parties to develop a long term comprehensive management process for the herd, as

required under section 12.5 of the Tłı̨chǫ Agreement. This initiative has included several meetings of the Bathurst Caribou Management Working Group, which is tasked with developing a mechanism to manage the Bathurst over the long-term. This mechanism may be a caribou board or body, similar to the Porcupine Caribou Management Board or Beverly and Qamanirijuaq Caribou Management Board. A Bathurst Caribou Harvesters' Gathering (Barnaby and Simmons 2013) was held in January 2013 to help define this management mechanism.

Short-term Management

Initial harvest reductions were implemented by ENR in 2006 after a population survey showed a significant decline in the Bathurst caribou herd. Harvest allowed for resident hunters was reduced to two bulls/year and big-game outfitter tags were reduced from 1,241 bulls in 2006 to 691 in 2007. After a further and more rapid decline documented in 2009, resident and big-game outfitter harvest in the Bathurst range was reduced to 0. Aboriginal harvest was reduced to a target of 300 caribou (80% bulls) in management zones R/BC/02 and R/BC/03. These 300 caribou were divided equally between the Tłı̨chǫ Government and Yellowknives Dene First Nation. Harvest has been monitored by a combination of community monitors, check-stations and officer patrols. These actions have occurred through joint management proposals submitted by the Tłı̨chǫ Government and ENR to the Wek'èezhìi Renewable Resources Board (WRRB) in 2009 and 2010, an agreement between the Yellowknives Dene First Nation and ENR in 2010, and recommendations since 2010 by the WRRB. The May 2010 joint management proposal and WRRB recommendations of October 2010 can be found on the WRRB public registry.

In 2014, ENR and the Tłı̨chǫ Government submitted an updated joint proposal for management of Bathurst caribou in Wek'èezhìi to the WRRB. Suggested actions included continued harvest management and a more focused predator management program centered on the Tłı̨chǫ communities. This proposal was suspended in late 2014 as a result of the June 2014 reconnaissance survey results and the series of meetings of leaders and boards with ENR in fall 2014.

Land Management

In recognition of concerns over the cumulative effects of development on the Bathurst range (including the calving grounds in Nunavut), ENR initiated a number of collaborative programs between 2012 and 2014 that relate to land management. These include a range management planning process for the entire Bathurst range, a cumulative effects assessment, monitoring, and management framework, and a number of workshops focused on wildlife monitoring better suited to cumulative effects assessment, including increased emphasis on standardized monitoring protocols.

BLUENOSE-EAST HERD

Population Surveys

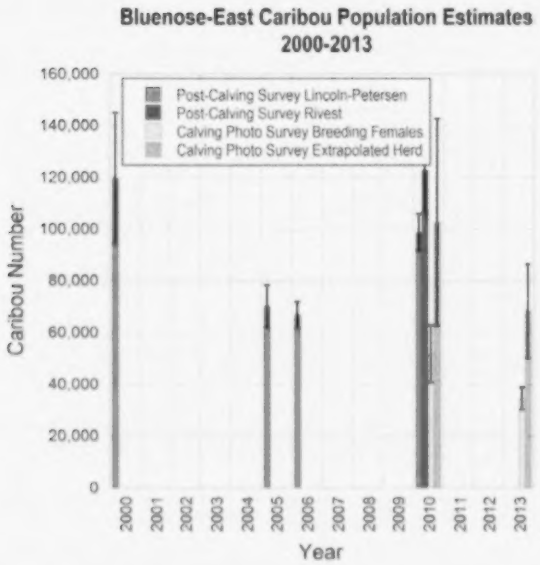


Figure 20. Population estimates from surveys of the Bluenose-East caribou herd 2000-2013. Post-calving surveys in 2000, 2005, 2006 and 2010 are shown in red as Lincoln-Petersen (LP) estimates. In 2010 a newer estimator (Rivest, purple) was used in addition to LP estimates. In 2010 and 2013, calving photo surveys in June were carried out for this herd and estimates of breeding females (green) and extrapolated estimates of herd size (blue) were determined.

Before 2000, the Bluenose-East herd was surveyed as part of the "Bluenose" herd (Cape Bathurst, Bluenose-West and Bluenose-East herds combined). Population surveys specific to the Bluenose-East herd were initiated in 2000. Post-calving surveys were carried out in July and an LP estimator of herd size was used (Figure 20). The surveys 2000-2010 suggested a decline to 2006, then an increase to 2010.

In 2010, ENR carried out a calving photo survey of the Bluenose-East herd as well as a post-calving survey in July. This was the first side-by-side comparison of the two survey methods on the same herd in the same year in the NWT. Details on the survey methods and population estimates are provided by Adamczewski et al. (2014). In brief, the June photo survey is designed to provide an estimate of the numbers of breeding females on the

calving grounds. This can be extrapolated to an estimate of herd size using ratios to add in non-pregnant cows and males. The post-calving survey is based on photos of caribou groups that are tightly aggregated in July in response to biting flies. Groups may number tens, hundreds or thousands and include males and females at least one year old. An adequate number of collars are needed to find the caribou groups, and a statistical correction is then applied to account for caribou not found and photographed.

From the June Bluenose-East 2010 survey, an estimate of breeding females of about 51,700 was derived. An estimate of adult caribou at least 1.5-years-old in the herd (*ca.* 102,700) was extrapolated from the estimate of breeding females using estimates of sex ratio from a fall composition survey and an estimate of pregnancy rate in cows at least 1.5-years-old.

From the July 2010 survey, photos were taken of 41 groups of caribou that included 44 of 47 collars in the herd, and 92,481 caribou at least one year old were counted on the photos. An estimate of herd size using an LP estimator provided a herd estimate of about 98,600 caribou at least one year old. A more recent and statistically more sound estimator of herd size using calculations of Rivest gave a herd estimate of 122,700 caribou at least one-year-old. This estimator had not previously been used in the NWT but has been accepted in Alaska and Québec, where it was developed.

Overall, all herd estimates from 2010 indicated a herd of at least 100,000 adult caribou (1-year-old+) and a likely herd size of about 120,000.

A post-calving survey of the Bluenose-East herd was attempted in July 2012 but was unsuccessful due to insufficient aggregation of caribou in much of the herd. This survey method has failed previously with the Bluenose-East herd in other years and has failed in other caribou herds (e.g. Porcupine and western Arctic herds in Alaska); it requires that nearly all the herd form large dense groups that can be photographed.

A calving photo survey of the Bluenose-East herd was carried out successfully in June 2013 and reported by Boulanger et al. (2014c). Estimates of the number of breeding females,

extrapolated herd size and the number of 1-year-old+ caribou estimated in the June survey area are shown in Figure 19. The estimate of breeding females and extrapolated herd size both declined significantly; the number of breeding females was reduced by 1/3 at 34,500 and the extrapolated herd estimate was reduced by a similar margin.

Calving Ground Reconnaissance Surveys

As described earlier for the Bathurst herd, calving ground reconnaissance surveys have been used for some caribou herds in the NWT to map calving grounds and as a lower-cost indicator to monitor the numbers of caribou on a herd's calving grounds, most of which are breeding cows. For the Bluenose-East herd, reconnaissance surveys of the calving grounds were the initial step in calving photo surveys in 2010 and 2013. A further calving reconnaissance survey was carried out in June 2014; results were reported by Boulanger et al. (2014d). Results of these reconnaissance surveys are shown in Figure 21, along with estimates of adults (1-year-old+) on the main calving area from the more intensive calving ground photo surveys.

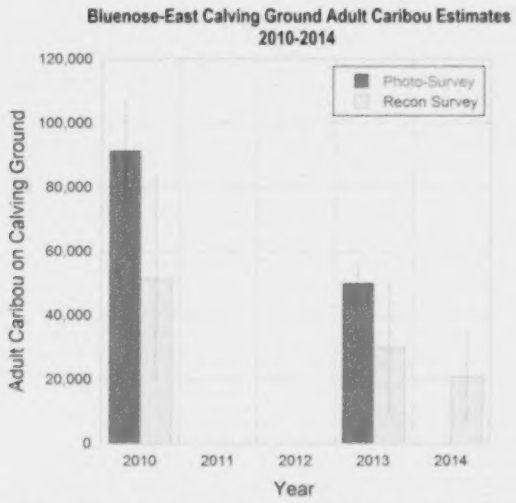


Figure 21. Estimates of adult caribou (1-year-old+) on the Bluenose-East herd's calving grounds in 2010, 2013 and 2014 from calving photo surveys and reconnaissance surveys.

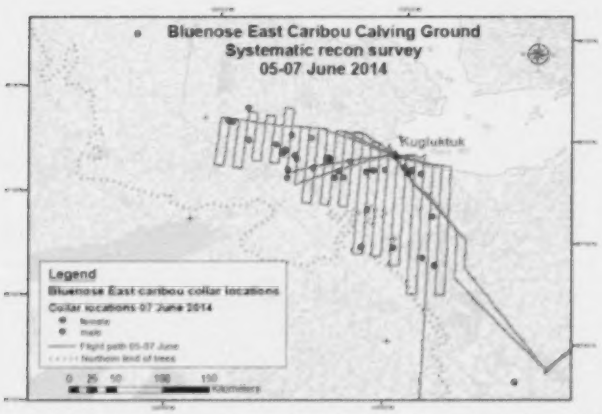


Figure 22. Flight lines and collared caribou locations (cows red, bulls blue) from June 5-7, 2014 calving reconnaissance survey over Bluenose-East calving grounds. Bulls, non-breeding cows and yearlings have been generally found south and east of Kugluktuk in recent years while the main calving grounds have been west of Kugluktuk.

Estimates from the reconnaissance surveys paralleled the trend in breeding females and extrapolated herd size in Figure 21. Because of the relatively low coverage and high variance on reconnaissance surveys, the results should be interpreted with caution. However, the relatively rapid declining trend for the Bluenose-East herd 2010-2013 appears to be continuing. Flight lines flown on the Bluenose-East 2014 June reconnaissance survey are shown in Figure 21, with collar locations of cows and bulls. As in recent surveys of this calving ground, most of the collared cows were in the main calving area west of Kugluktuk, while most of the bulls and a few cows were south and east of Kugluktuk where bulls, yearlings and non-breeding cows were concentrated in 2010 (Adamczewski et al. 2014).

Spring Calf Recruitment Surveys

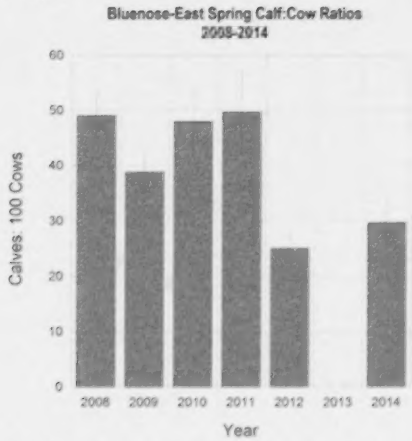


Figure 23. Spring calf:cow ratios for the Bluenose-East herd 2008-2014 (no survey in 2013 because herds were mixed).

As described earlier for the Bathurst herd, spring (late-winter) composition surveys to monitor the ratio of calves:100 cows are used to provide an index of the number of calves in a caribou herd surviving to about ten months of age. Spring calf:cow ratios for the Bluenose-East herd 2008-2014 are shown in Figure 23. Similar to the Bathurst herd, calf:cow ratios of 38-50:100 cows were recorded 2008-2011, but lower ratios of 24 and 30 were recorded in 2012 and 2014.

Adult Cow Survival Estimates

As noted earlier, caribou population trend is most sensitive to the survival rate of adult cows and cow survival rates of 83% or higher are generally associated with stable herds. Cow survival based on a model that uses all demographic information available for a population was estimated at 73-75% for the Bluenose-East herd 2010-2013 (Boulanger et al. 2014c), consistent with a rapid decline documented from surveys over this period.

Fall Composition Surveys

Fall composition surveys to estimate the ratio of bulls:cows in the Bluenose-East herd were carried out in late October 2009 and 2013. In 2009, 4,531 caribou in 79 groups were classified and 42.6 bulls:100 cows were observed. In 2013, 5,381 caribou in 117 groups

were classified and a similar ratio of 42.9 bulls:100 cows was observed. Bull:cow ratios of about 50:100 are common in caribou herds (Bergerud 2000).

Pregnancy and Condition

Information on pregnancy rates in Bluenose-East caribou is available for 2010-2014 from health and condition monitoring carried out collaboratively with Tłı̨chǫ Government and monitors during winter harvest of caribou; a summary collated by I. Stasiak (ENR) is included as Appendix 1. Pregnancy rates were determined in late winter by the presence of a fetus, with the results in Table 5 below.

Table 5. Pregnancy rates of Bluenose-East caribou cows 2010-2014 recorded either from hunter-killed animals or from blood samples of caribou captured for collar deployment.

Date	Hunter kits/Collections	Collaring	Combined
March 2014	Adult cows 44/50 (88%)	7/8 (87.5%)	51/58 (87.9%)
March 2013	Adult cows 17/21 (81.0%)		
March 2012	Adult cows 22/29 (75.9%)	27/42 (63.4%)	49/71 (69.0%)
February 2011	Adult cows 11/11 (100%)		
March 2010	Adult cows 31.48 (64.6%)	8/9 (88.9%)	22/28 (68.4%)

Additional pregnancy information was available in 2010, 2012 and 2014 from cows captured in late winter to deploy collars (Table 5). Blood was collected and pregnancy was assessed based on serum progesterone levels (high in pregnant cows, very low in non-pregnant cows). In 2010, eight of nine cows were pregnant (89.0%); in 2012, 27 of 42 were pregnant (64%) and in 2014 seven of eight were pregnant (87.5%). Results from smaller samples of ten to 15 or less should be used with caution.

Additional information on pregnancy rates of cows captured for collar deployment NWT-wide in March/April 2012 are listed in Table 2 (included earlier in the Bathurst caribou section). The overall pregnancy rates across herds in 2012 were 60.9%.

Condition monitoring of hunter-killed Bluenose-East caribou from Tłı̨cho hunters included measuring back fat at the base of the tail. Average back fat thickness was about 10 mm in 2010 and 2011, lower at <4mm in 2012 and slightly higher in 2013 and 2014 (Figure 24). As a comparison, back fat thickness averaged 13.9 mm in late winter in Beverly caribou at

least two years old in 1980-1987 (n=696) at a time when the Beverly herd was increasing (Thomas and Kiliaan 1998). Back fat averaged 16 mm in pregnant cows (n=583) and 3.1 mm in non-pregnant Beverly cows (n=113). By this standard, Bluenose-East cows were relatively lean overall in 2010-2014, their condition was relatively poor in 2012 and marginally better in 2013 and 2014.

To place the pregnancy rates estimated for the Bluenose-East herd 2010-2014 in context, the pregnancy rate of Beverly cows at least two years old averaged 83.7% in 1980-1987 (n=708) and 86.1% in cows at least three years old (n=588) at a time when the Beverly herd was growing. In the George River herd, pregnancy rates of breeding-age cows averaged 89-100% during a period of increase in the herd in the 1970s, and were 59-78% during the early 1990s when the herd was declining (Bergerud et al. 2008). Recognizing the limited sample sizes in some years, the pregnancy information suggests that Bluenose-East caribou had relatively low pregnancy rates in 2010 and 2012 and better pregnancy rates in 2011, 2013 and 2014. The NWT-wide low pregnancy rate in multiple herds points to a large-scale effect, possible weather-mediated, that may have affected cow condition in the breeding season on some ranges (Cameron et al. 1993) in 2012. The Bluenose-East condition data for 2010-2014 suggest that caribou were relatively lean over this period in comparison to the Beverly herd in the early 1980s, particularly in 2012-2014.

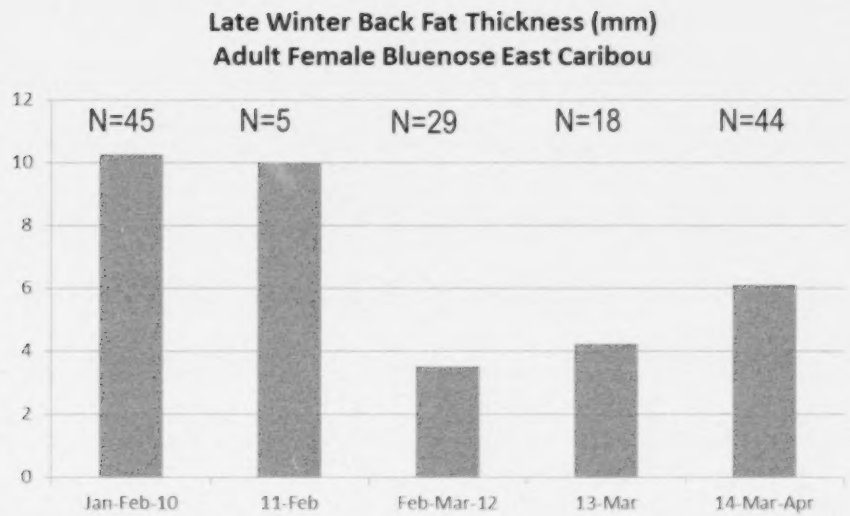
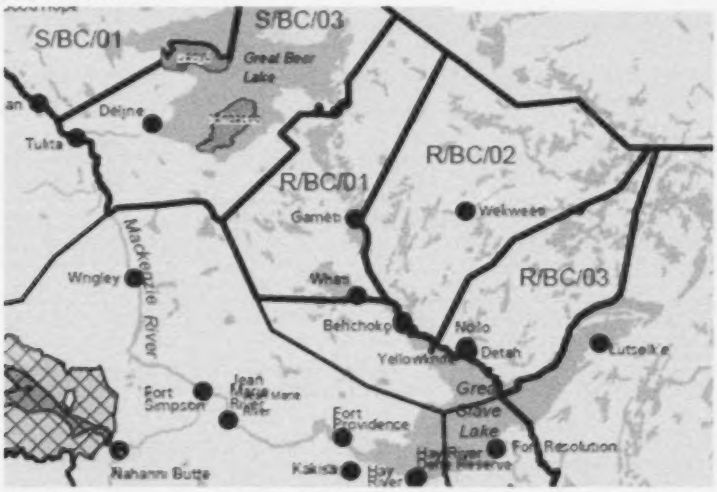


Figure 24. Back fat thickness in hunter-killed Bluenose-East caribou cows during winters 2010-2014 as collected by Tłı̨chǫ hunters during community hunts. Note small sample in 2011.

Harvest Estimates



Harvest Season:
2009-2010: 3,466
2010-2011: 2,918
2011-2012: 1,766
2012-2013: 2,562
2013-2014: 3,016
Average: 2,746
(At least 65% Cows)

NU Harvest (Kugluktuk):
300-1000 (GN staff)

Figure 25. Barren-ground caribou management zones in the NWT (mostly North Slave Region, left) and estimates of harvest from the Bluenose-East herd 2009-2013 (right).

Harvest of the Bluenose-East caribou herd in the Sahtú region was traditionally associated with the community of Délı̨nę on Great Bear Lake on the herd's winter range. Average annual harvest associated with Délı̨nę 1998-2005 was 1,260 caribou/year with about 60% cows, based on a Sahtú Renewable Resources Board (SRRB) harvest study in those years.

Harvest was also associated with Kugluktuk in Nunavut and Tłı̨chǫ communities in NWT; however the main harvest in the North Slave Region in winter was from the Bathurst herd before 2010 because of its accessibility on winter roads. Resident harvest and guided-outfitter harvest of barren-ground caribou in the region was also primarily from the Bathurst herd prior to 2010.

Since the major harvest restrictions on the Bathurst herd in 2010, harvest in the North Slave Region (primarily zones U/BC/01, R/BC/01, R/BC/02 and R/BC/03) has been monitored by a combination of check-stations, community monitors, officer patrols and estimates of community harvest from wildlife officers (Déljnę, Kugluktuk in Nunavut). Based on collar locations, the Bluenose-East herd has wintered primarily in R/BC/01 and S/BC/03, with some use of R/BC/02 (Figure 14). Overlap of winter range use with the Bathurst herd has been substantial in some winters. Locations of harvested caribou were mapped and assigned to herd based on zones and collared cow locations. The average estimated/reported Bluenose-East harvest has been about 2,746 caribou/year, and likely at least 65% cows (Figure 25). These estimates are considered minimums; wounding losses are not included, some harvest is un-reported and the true harvest may be at least 4,000/year. The increased Bluenose-East harvest since the winter of 2009-2010 may reflect a deflected Bathurst harvest. Some of the harvest in R/BC/01 has likely been from the Bathurst herd (Figures 13, 14, 15; Table 1), but the predominance of Bluenose-East collar locations and the relative sizes of the two herds suggest most of this harvest has been from the Bluenose-East herd.

Movements of Collared Bluenose-East Caribou

In the earlier section on Bathurst caribou, rates of switching between Bathurst and Bluenose-East calving grounds and neighbouring herds on either side were assessed based on collared cows for which two or more consecutive annual calving ground locations were known (Figure 19). This graphic is shown again below. Sample numbers for the Bluenose-East herd were higher than for the Bathurst herd, which increases confidence in the rates

of switching and fidelity reported. As with the Bathurst herd, there was no evidence for large-scale movement from the Bluenose-East calving ground 2010-2014.

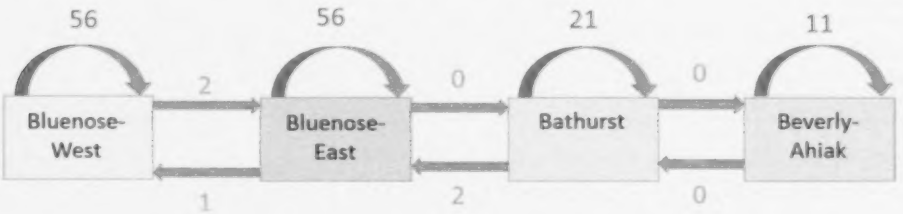


Figure 19 (shown earlier). Rates of switching between calving grounds of collared caribou cows from four neighbouring herds where at least two consecutive June locations were known, 2010-2014. Each pair of locations represents one data point. The numbers of cases where a cow returned to the same calving ground are in blue and the cows that switched are in red.

Management Context for the Bluenose-East Herd

Overall Bluenose-East Herd Management

A management plan developed through a co-management process for the Bluenose caribou herd was finalized in 2000, but was not formally signed by all participants. Understanding of the "Bluenose" herd evolved in the 1990s, particularly with the use of satellite radio collars that demonstrated that there were three separate calving grounds and three separate herds in this region. These were then named the Cape Bathurst, Bluenose-West and Bluenose-East herds; beginning in 2000, post-calving population surveys specific to the three herds were first carried out.

A management plan for the Cape Bathurst, Bluenose-West and Bluenose-East herds was developed by the Advisory Committee for Cooperation on Wildlife Management (ACCWM, composed of chairs of co-management boards) beginning in 2007 and was finalized in 2014 (ACCWM 2014a). The plan provides for monitoring and management options depending on the herds' status. A companion document (ACCWM 2014b) was developed by ENR as a technical report on the status, ranges and biological monitoring of the herd. A second companion document (ACCWM 2014c) is a summary of community engagement

meetings and comments from community participants 2007-2013 in several rounds of meetings.

Short-term Management

Resident and guided-outfitter harvest of Bluenose-East caribou was closed in 2010 after declines were documented in the Bathurst and other barren-ground caribou herds. Aboriginal harvest of this herd was not restricted as of September 2014 but harvest management was under discussion. A portion of the Bluenose-East herd may winter in management zones R/BC/02 and R/BC/03, where Aboriginal harvest has been restricted since 2010 to promote recovery of the Bathurst herd. Harvest of Bluenose-East caribou was monitored 1998-2005 in the Sahtú region by the SRRB. Since 2010, harvest of this herd (primarily in the North Slave Region) has been monitored by a combination of community monitors, check-stations, officer patrols and estimates of community harvest from wildlife officers (Déline and Kugluktuk). Recommendations for voluntary Aboriginal harvest restriction were made in 2006 by the SRRB and in 2010 by the WRRB (2010), but were not enacted.

Land Management

The ACCWM management plan includes recommendations on land use that depend on the herds' status. Overall, current concerns over mining, roads and other land uses are limited for the Bluenose-East range as there are no active mines in NWT or Nunavut. ENR has initiated a number of collaborative programs between 2012 and 2014 for the Bathurst range, including a range management planning process, a cumulative effects framework and regional scale monitoring programs in collaboration with diamond mines that may have application to the Bluenose-East herd's range in future. ENR will continue to engage in all environmental assessment processes in NWT and Nunavut that may affect trans-boundary herds like the Bluenose-East.

CARIBOU CYCLES AND DEMOGRAPHICS OF DECLINE

Caribou Cycles

Large changes in abundance of migratory barren-ground caribou herds have long been known to Aboriginal hunters and elders (Beaulieu 2012, Bergerud et al. 2008). Presence of caribou on winter ranges southeast of Great Slave Lake in the Rocher River area alternated between scarcity and abundance on a 30-year cycle with peaks in 1924, 1954, 1984 and an expected peak in 2014 (Beaulieu 2012). Traditional knowledge of Tłı̨chǫ elders identified a high in Bathurst caribou in the 1940s and low numbers before and after this peak (Zalatan et al. 2006); a method of tracking abundance of caribou from annual spruce root scars on traditional migration trails also identified higher Bathurst caribou numbers in the 1940s and identified a more recent high in the 1980s and 1990s that concurred with biologists' surveys over the more recent period (Zalatan et al. 2006, Figure 26).

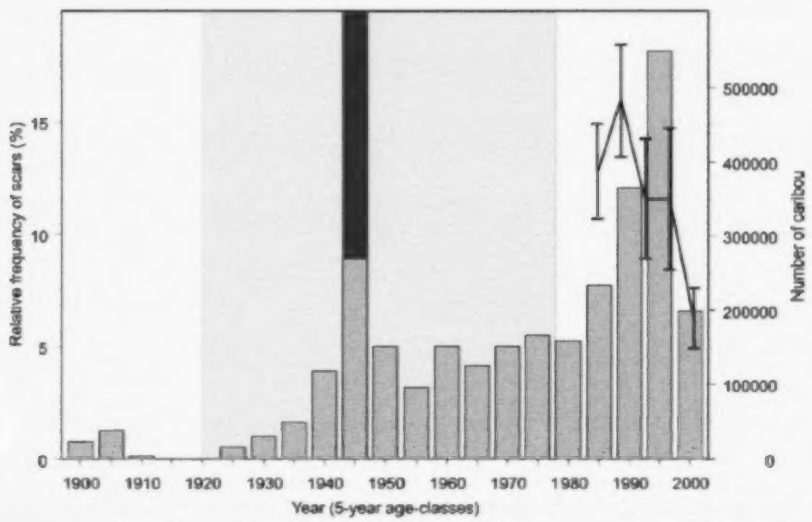


FIGURE 3. Bathurst herd caribou numbers from aerial photography surveys (1984–2003; black line; means ± SE), and abundance patterns (high = dark gray shading or low = light gray shading) derived from traditional knowledge of elders from the Dogrib First Nation relative to the scar frequency distribution for the northwest sites (Bathurst herd; bars).

Figure 26. Relative abundance of caribou on traditional Bathurst migratory ranges inferred from spruce root scars 1900-2000, from Tłı̨chǫ (Dogrib) elders (1920s-1980s), and from biologists' surveys (1980s-2000s). (Zalatan et al. 2006)

Large changes in Bathurst caribou abundance are not unique to this herd; the George River herd in Quebec/Labrador was very low in the 1950s (Bergerud et al. 2008), then increased to a peak of 700,000-800,000 in the late 1980s or early 1990s and has since declined to an estimated 14,200 in 2014 (Figure 27).

A re-construction of the George River herd's relative abundance since the 1700s by Bergerud et al. (2008) using spruce root scarring along with related information including hunter success at traditional water crossings suggests that the length of cycles between high and low caribou numbers is not always predictable (Figure 28), and that the highs and lows are variable. This re-construction suggested historic highs in the late 1700s, late 1800s and late 1900s and additional smaller peaks in the 1900s. These long-term fluctuations have likely occurred many times over thousands of years, with or without significant human influences.

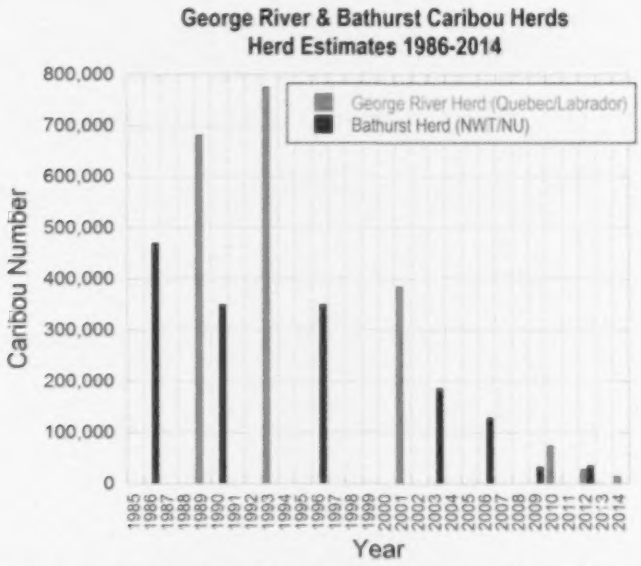


Figure 27. Relative abundance of the Bathurst caribou herd in NWT/Nunavut and of the George River herd in Quebec/Labrador 1985-2014. Bathurst estimates ENR extrapolated from calving photo surveys; George River caribou estimates 1989-2001 from co-management plan for this herd 2004 and from news-stories CBC 2010-2014.

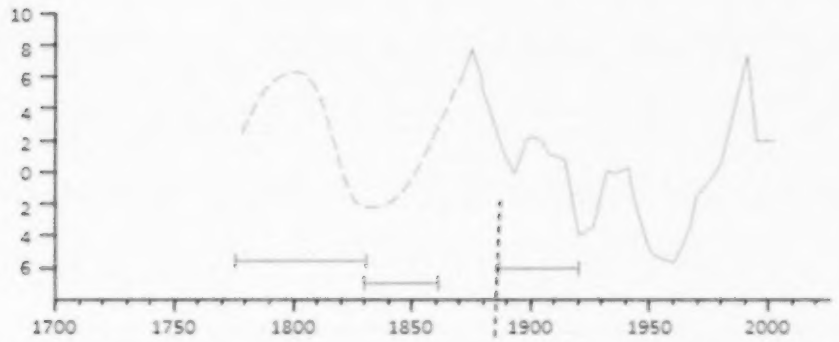


Figure 28. Re-constructed relative abundance of the George River caribou herd 1750-2000 based on spruce root scarring. (Adapted from Bergerud et al. 2008)

One further example from an Alaskan/Yukon caribou herd demonstrates that long-term fluctuations in numbers of caribou herds may not follow a predictable cycle; herds may sometimes decline to relatively low numbers and remain there for extended periods. The Fortymile herd was once estimated at 300,000-500,000 in the 1920s, declined to about 50,000 in the 1950s, then declined further to a low estimated at 7,000 in the early 1970s (Valkenburg et al. 1994). Figure 29 charts the history of this herd from 1950-1990. The prolonged low in caribou numbers appeared to result from a combination of high harvest, wolf predation, poor weather, and years of very poor calf recruitment (missing cohorts), and included two periods of wolf control. A recovery program for this herd included harvest limitation and non-lethal wolf removal and has been considered a successful example of a recovery program developed through a co-management process (Gronquist et al. 2005).

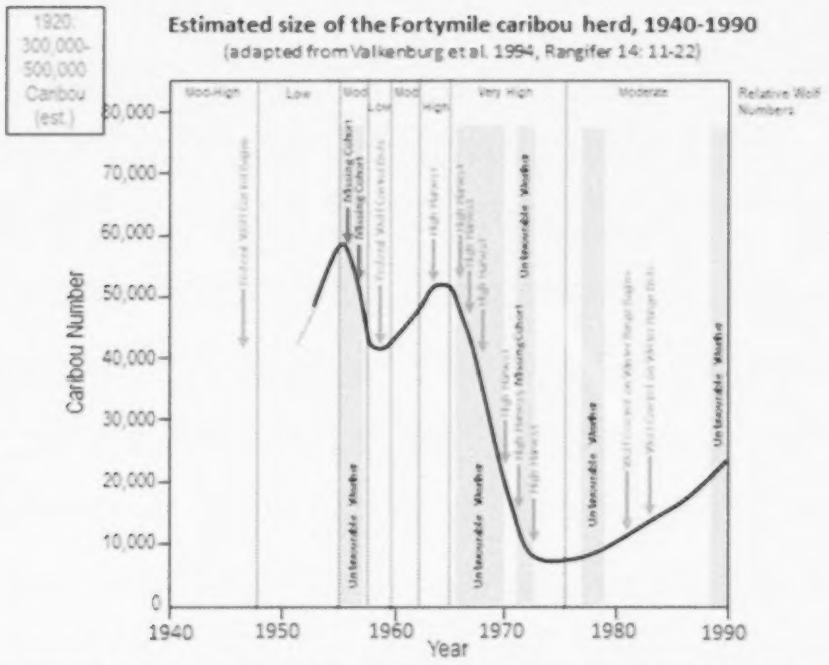


Figure 29. Estimated size of the Fortymile caribou herd 1940-1990, adapted from Valkenburg et al. 1994.

Factors that Drive Cycles

Factors that drive large-scale increases and decreases of caribou herds are multiple and no one single factor explains these changes fully. However, because trends in caribou abundance are often similar regionally (Gunn 2003; exceptions do occur between neighbouring herds), climatic factors are likely key drivers that operate at large geographic scales (Gunn 2003, Vors and Boyce 2009). Decadal weather oscillations [North Atlantic Oscillation (NAO), Arctic Oscillation (AO), and Pacific Decadal Oscillation (PDO)] have been linked to population trend in four migratory tundra caribou herds in Alaska (Joly et al. 2011), but each herd was affected differently. Poorer growth of summer vegetation and reduced access to forage in winter (poor snow conditions) were likely main effects of adverse weather conditions (Joly et al. 2011).

One of the key effects of climate on migratory caribou is productivity of vegetation on the summer range (Gunn 2003); if cows have good foraging conditions over the summer, they are likely to be in good condition during the breeding season, leading to high pregnancy

rates and high initial calf productivity and early calf survival in the following June (Cameron et al. 1993). Conversely, caribou cows in poor condition may not be pregnant every year (Cameron 1994).

At very high density, caribou may affect tundra vegetation negatively (thus their own forage and condition) by heavy grazing and trampling, as documented for the George River herd in the early 1990s (Manseau et al. 1996). However, negative effects of weather and environmental conditions can occur when herds are not at peak numbers. Between 2000 and 2006, late calving and low calf productivity and a likely declining natural trend were documented in the Cape Bathurst, Bluenose-West and Bathurst herds (Adamczewski et al. 2009 In Prep). The large geographic scale covered by these three herds and the similarity of the effects over the same time period implicate weather (possibly affecting summer range and cow condition in the breeding season) as a likely key factor. All three of these herds were well below their historic highest herd size.

Predicting the effects of future weather on caribou is challenging as altered weather may have multiple implications for caribou (Joly et al. 2011). Research on the Beverly herd's winter range in the 1980s (Thomas et al. 1996, 1998) and on the Bathurst herd's winter range in the 2000s (Barrier and Johnson 2012) demonstrated caribou avoidance of recently burned areas (40-60 years) and a preference for forest at least 100 years old (Thomas et al. 1996, 1998) but suggested that overall winter range quality and lichen availability were adequate for these herds during the study periods. An increased frequency of big-fire years (such as 2014 in the NWT, Figure 30) could have negative implications for caribou winter range if the forest shifts to a much younger age distribution with less of the slow-growing lichen caribou depend on in winter in older forests (Joly et al. 2012, Gustine et al. 2014).

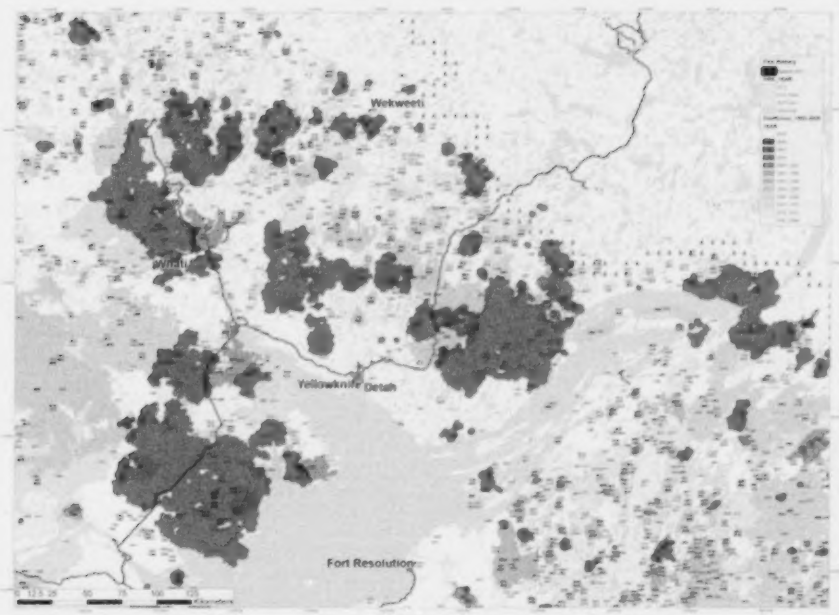


Figure 30. Fire map showing burned areas from recent decades in the NWT in the region surrounding Great Slave Lake. Fires of 2014 are in grey. This map should be considered a draft as the fire season had not ended when the fires were mapped. (Map: GNWT/B. Croft, ENR)

Predation is most likely to affect migratory caribou population trend at lower numbers and may prolong the period of low numbers (Valkenburg et al. 1994, Gunn 2003, Bergerud et al. 2008). Hunter harvest is also most likely to affect caribou herds at lower numbers, particularly if the herd is declining naturally and if the scale of the harvest is large relative to herd size and composed primarily of breeding cows (Boulanger et al. 2011).

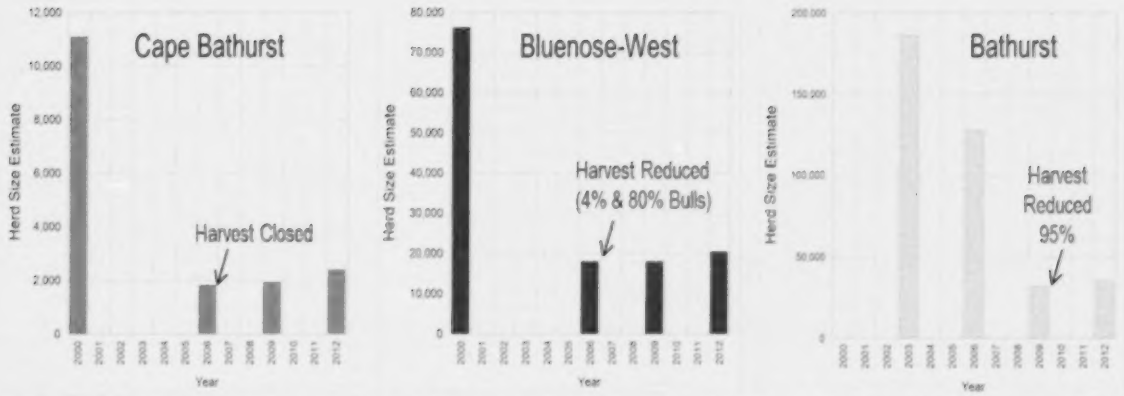


Figure 31. Population trend and harvest reduction in the Cape Bathurst, Bluenose-West and Bathurst herds 2000-2012.

Declines in the Cape Bathurst, Bluenose-West and Bathurst herds showed a similar pattern of a natural declining trend 2000-2006/2007 that was accelerated at lower numbers by substantial harvest (Adamczewski et al. 2009 In Prep), with a shift to a stabilizing trend in all three herds following major harvest restriction and improved calf productivity and survival (Figure 31).

DEMOGRAPHICS OF DECLINE IN CARIBOU

Clearly defining longer-term drivers of change in caribou herds is complex; weather can play a major role at various times of year, while predators and harvest may have smaller or larger roles. At a shorter time-scale in any particular herd, whether the herd is increasing, stable or declining is ultimately an annual balance between losses (caribou that die) and gains (calves that are born and survive to add to the herd). Key variables are (1) pregnancy rate or initial productivity, (2) calf survival through the first year, and (3) survival rate of cows, the last of these being the most critical (Crête et al. 1996, Boulanger et al. 2011). Factors affecting caribou abundance will likely translate into changes in these vital rates. A year or a period of years with very good summer range conditions and limited insect harassment will likely manifest as years with high pregnancy rates and high summer calf survival. Predators (wolves and bears) affect survival rates of calves and adults, and a substantial cow harvest will reduce the survival rate of cows.

In the George River herd in Québec/Labrador, pregnancy rates during the herd's increasing phase in the 1970s averaged 89-100%, cow survival estimates averaged 90-95%, and late-winter calf:cow ratios averaged 28-60 calves:100 cows (Bergerud et al. 2008). In the 1990s when the herd was in the early stages of decline, pregnancy rates averaged 59-78%, cow survival averaged 80-84% and late-winter calf recruitment averaged 9-19 calves:100 cows (Bergerud et al. 2008). A combination of low vital rates can lead to very rapid rates of decline: the George River herd was estimated at 74,000 in 2010, 27,600 in 2012 and 14,200 in 2014.

BATHURST AND BLUENOSE-EAST POPULATION TREND IN 2014

Bathurst Herd in 2014

In this section the evidence for decline in the Bathurst herd between 2010-2014 is assessed and likely causes for the low numbers of caribou recorded during the June 2014 calving ground reconnaissance surveys are considered. For clarity, possible explanations for the low numbers of caribou seen during the reconnaissance surveys are listed in Table 6, divided into potential factors resulting from the survey and potential biological factors.

Survey-Related Factors

The main limitation of June calving ground reconnaissance surveys is that they have relatively low coverage and the variance on estimates of caribou numbers is high. The relatively low precision means that survey estimates could be higher or lower than the true numbers. The Bathurst core calving area in June 2014 was small, so that even with 5 km spacing on flight lines, there were only eight lines flown over the core calving area. The June 9 and 13, 2013 core calving areas were also small and had few survey lines (Boulanger et al. 2014b). A more precise photo survey in June would have higher coverage and a lower variance attached to estimates of caribou numbers. However, despite the high variance, previous reconnaissance surveys of the Bathurst herd have reliably tracked the trend found in more precise calving ground photo surveys 2006-2009 and 2009-2012.

One potential reason for low numbers of caribou seen during the June 2014 reconnaissance survey could be if the pregnancy rate was low, meaning a significant numbers of cows were not on the main calving area. Information on pregnancy in Bathurst cows in 2014 was limited. Collared cows usually show a clear drop in movement rates when they calve. Movement rates of some collared cows did not decline below 5 km a day for a significant period of time in 2014 compared to 2012 and 2013 (Boulanger et al. 2013b), suggesting these cows were not pregnant. The pregnancy rate among 13 cows captured in March 2014 for collar deployment was 69% (9/13). However, 17 of 18 Bathurst collared cows were in the core calving area during the June 2014 survey, suggesting that a large proportion of the herd's cows (pregnant and non-pregnant) were on the calving grounds. Some non-

pregnant cows are found on the calving grounds at the peak of calving in June, while others may be south of it (e.g. Bluenose-East herd in 2010, Adamczewski et al. 2014).

Weather conditions during the June 2014 survey were excellent and snow cover on the main calving ground was limited, similar to 2012. The issues that occurred in June 2013 (poor sightability on June 9 due to patchy snow cover, possible post-calving aggregation on June 13) did not apply to 2014 or 2012.

If there were significant numbers of breeding cows in areas outside the survey area, this could have biased the survey results low. However, the Bathurst herd appears to have maintained a pattern of a single concentrated core calving area with very few cows in peripheral areas in recent years (see Figure 7, Nishi et al. 2014, Bathurst calving ground in 2009, and Boulanger et al 2014a, Bathurst calving ground 2012) that continued in 2013 and 2014. In calving photo surveys (2006, 2009 and 2012), collared cow locations have consistently coincided with the concentrated calving area defined in each year.

Table 6: Potential reasons for decline in estimates of Bathurst herd in 2014.

Reason for decline	Evidence	Likelihood
Survey-related factors		
Low coverage (16%), high variance on recon resulted in larger aggregations of caribou not being sampled	Possible given lower recon survey coverage, but low coverage could bias the estimate low or high. Photo survey with higher coverage will provide more precise, definitive estimate. Reconnaissance surveys have tracked trend well in Bluenose-East and Bathurst herds.	Possible
Lower pregnancy rate resulted in fewer females in the core calving area.	Movement rates never declined to below 5 km per day for some collared cows. 9 of 13 (69%) of Bathurst cows captured March 2014 were pregnant (small sample). However, 17 of 18 collared caribou were in core area June 2014; main calving area was one well-defined block.	Possible
Lower sightability of caribou on calving ground compared to previous years	No evidence; survey conditions nearly ideal (good weather, little snow) similar to 2012.	Low
Breeding caribou not in the core calving area with collared caribou were missed	Very low densities of caribou were detected on the margins of the core area. 2012 core area was of similar size. Herd has maintained a single core area for calving since 1996. 17 of 18 collared cows in core calving area.	Low
Biological factors		
Declining trend due to reduced overall adult (cow) survival rates	Demographic analysis with the 2012 survey (Boulanger et al. 2014a) suggested that female survival rates in 2012 (78%) were still below levels needed for stable herd; herd status "fragile".	Probable
Reduced natural (cow) survival rates	Lower recruitment in 2012, 2013, and 2014 than in 2010-2011; reduced recruitment correlated with reduced natural adult survival (Bergerud 2000); harvest alone could not account for apparent decline 2012-2014.	Probable
Harvest mortality decreased number of breeding females, decreased overall cow survival rates	Estimated/reported harvest in R/BC/03 and R/BC/03 300 or less with variable sex ratio; some harvest may have occurred in R/BC/01 because of overlap with Bluenose-East herd in some winters (e.g. 2013) but low collar numbers limit assessment. Some un-reported harvest	Possible/Probable

Reason for decline	Evidence	Likelihood
	Survey-related factors	
	occurs.	
Low pregnancy rate in some winters associated with low calf productivity and survival	Limited info on Bathurst pregnancy rates available; pregnancy has been generally high (small samples).	Possible
Reduced calf recruitment 2012-2014 affected recon survey results in 2014	Reduced spring calf:cow ratios 2012, 2013, 2014. Calves born 2012 and 2013 (but not 2014) could influence 2014 survey results.	Possible
Large-scale movement of cows from Bathurst range to other herds	Rates of collared cow switching to neighbouring herds very low 2010-2014 (consistent with other studies). Caveat in analysis is limited collar numbers.	Low

Biological Factors

The likeliest reasons for the apparent decline in caribou on the Bathurst calving ground are low cow survival rates and reduced productivity.

Previous demographic analyses suggested that survival rates of breeding females in the Bathurst herd had improved from 2006-2009 but were still low in 2009-2012 (78%). This analysis considered whether breeding female population size was at the expected number given recruitment levels (as estimated from calf-cow ratios) in years prior to the calving ground survey. The breeding female population size was lower than expected, which suggested that female adult survival was low and potentially limiting the ability of the herd to increase. It is unlikely that harvest alone could have resulted in the apparent decline 2012-2014 on the calving grounds, suggesting that the natural survival rate of Bathurst cows may have been reduced over this period. Lower spring calf:cow ratios 2012-2014 may also be indicative of lower natural cow survival rates, given the correlation between calf recruitment and natural survival rates of caribou (Bergerud 2000).

Reduced calf survival in 2012 and 2013 could have contributed to the low caribou numbers seen on the Bathurst calving ground in 2014. Evidence for reduced pregnancy rates in this herd is limited, with some indication of reduced pregnancy rates in 2014. NWT-wide, the 61% pregnancy rate in cows captured for collars in 2012 suggests a large-scale, potentially

weather-mediated effect, although 12 of 13 Bathurst cows captured that year were pregnant.

The role of harvest in the apparent Bathurst decline is somewhat difficult to assess. Aboriginal caribou harvest in R/BC/02 and R/BC/03 has been limited to 300 annually since 2010 to promote recovery of the Bathurst herd. There is likely some additional unreported harvest and some wounding loss and the target sex ratio of 20% or less cows has not generally been achieved. However, this scale of harvest from a herd of 32,000-35,000 (300-400 or around 1% of the herd) could not account for the apparent decline 2012-2014. Low numbers of Bathurst collars have made it difficult to assess how much of the Bathurst herd has wintered in R/BC/01. The possibility of significant Bathurst caribou harvest in R/BC/01 in some winters (e.g. 2013, see Figure 15) exists but is difficult to quantify.

There was no evidence for large-scale movement from the Bathurst herd to either of its neighbors (Bluenose-East and Beverly and Ahiak herds) from 2010-2014, based on the high fidelity of collared cows returning annually to the Bathurst calving ground (Figure 19).

Bluenose-East Herd in 2014

In this section, the evidence for decline in the Bluenose-East herd between 2010-2014 is assessed and likely causes for the low numbers of caribou recorded during the June 2014 reconnaissance survey are considered. For clarity, possible explanations for the low numbers of caribou seen during the reconnaissance survey are listed in Table 7, divided into potential factors resulting from the survey and potential biological factors.

Survey-related Factors

The main limitation of the June reconnaissance surveys is that they have relatively low coverage and the variance on estimates of caribou numbers is high. This means that survey estimates could be higher or lower than the true numbers. A more precise photo survey in June would have higher coverage and a lower variance attached to estimates of caribou

numbers. However, there were 20 flight lines over the main Bluenose-East calving area in 2014 (See Figure 22); this herd's calving ground has been spatially much larger than the Bathurst calving ground. Previous reconnaissance surveys of the Bathurst herd have reliably tracked the trend observed in more precise calving photo surveys 2006-2009 and 2009-2012 and in the Bluenose-East herd 2010-2013.

Another potential reason for low numbers of caribou seen during the June 2014 Bluenose-East reconnaissance survey could be if the pregnancy rate was low, meaning significant numbers of cows were not on the main calving area. The pregnancy rate of hunter-killed Bluenose-East caribou in winter 2014 was 88% (44 of 50), which indicates a relatively high pregnancy rate that winter. In addition, the reconnaissance survey coverage was comprehensive, taking in the main calving area west of Kugluktuk and the areas south and east of Kugluktuk where bulls, yearlings and non-breeding cows have been found in recent years, and including nearly all the cow and bull collars.

Weather conditions during the June 2014 Bluenose-East survey were good and snow cover on the main calving ground was limited. There was greater snow cover on more peripheral western portions of the survey area but few caribou in the area. Overall, observers' ability to sight caribou was good.

If there were significant numbers of breeding cows in areas outside the survey area, this could have biased the survey results low. However, the June 2014 Bluenose-East recon survey coverage was comprehensive (Figure 23; Boulanger et al. 2014d), covered the main calving area that has been documented since 2010 and earlier, and included coverage of the areas east and south of Kugluktuk where non-breeding cows, yearlings and bulls have been concentrated during several surveys. Previous surveys in 2010 and 2013 (Adamczewski et al. 2014, Boulanger et al. 2014c) did not detect any aggregations of breeding cows in these southern/eastern areas. The likelihood of a large proportion of the herd's cows being missed by the collars and by the extent of the survey area is low. Overall, survey-related factors in June 2014 are unlikely to have contributed significantly to the apparent decline in the herd.

Table 7: Potential reasons for decline in estimates of the Bluenose-East herd in 2014.

Reason for decline	Evidence	Likelihood
Survey-related factors		
Low coverage (8%), high variance on recon resulted in larger aggregations of caribou not being sampled	Possible given the lower reconnaissance survey coverage, but low coverage and high variance could bias count low or high. Photo surveys with higher coverage provide more precise, definitive estimate. Reconnaissance surveys have tracked trend well in Bluenose-East and Bathurst herds.	Possible
Lower pregnancy rate resulted in fewer females in the core calving area.	Movement rates of collared females were below 5 km/day during survey with most cows in the core calving area. Initial reconnaissance survey covered areas with collared cows and bulls. Pregnancy in hunter-killed Bluenose-East caribou in 2014 was 88% (44 of 50).	Low
Lower sightability of caribou on calving ground compared to previous years	Possible that snow cover reduced counts in peripheral areas of the calving ground (to the west). Unlikely to cause a large degree of bias in estimates. Generally good survey conditions 2014.	Low
Breeding caribou not in the core calving area with collared caribou were missed	Seven of 12 female caribou were contained within the core calving area. Lower densities of caribou were observed around collared caribou not in the core area. Overall survey area was comprehensive.	Low
Biological factors		
Demographic decline 2010-2013 continued due to reduced overall adult (cow) survival rates	Demographic analysis (part of 2013 survey report, Boulanger et a. 2014c) suggested female survival rates were low (0.73-0.75); possible combination of reduced natural survival rates and harvest.	Probable
Reduced natural (cow) survival rates	Lower recruitment in 2012 and 2014 than in 2010-2011; reduced recruitment correlated with reduced natural adult survival (Bergerud 2000); harvest alone could not account for 2010-2013 breeding female decline (Boulanger et al. 2013c).	Probable
Harvest mortality decreased number of breeding females, decreased overall cow survival rates	Estimated/reported harvest was at least 2,700 caribou/year with at least 65% cows. Harvest was likely under-reported. Harvest has likely not declined in size 2010-2014, thus effect has likely increased as herd declined.	Probable
Low pregnancy rate in 2010 and 2012 associated with poor condition and reduced calf productivity	Pregnancy rate (hunter-killed) 64% in 2010; 76% (hunter-killed), 64% (captured cows) in 2012. Caribou relatively lean 2010-2014 (hunter-killed).	Possible

Reason for decline	Evidence	Likelihood
	Survey-related factors	
Reduced calf recruitment 2012-2014 affected recon survey results in 2014	Somewhat lower spring calf:cow ratios 2012 and 2014; no ratio for 2013. Calves born 2012 and 2013 (but not 2014) could influence 2014 survey results.	Possible
Large-scale movement of cows from Bluenose-East range to other herds	Rates of collared cow switching to neighbouring herds very low 2010-2014 (consistent with other studies).	Low

Biological Factors

The likeliest biological explanation for the reduced numbers of caribou on the Bluenose-East calving grounds in June 2014 is a continuation of the decline documented from June 2010 and June 2013 calving photo surveys. This was likely the result of a combination of low natural survival rates, reduced pregnancy rates in some years (2010 and 2012), reduced calf recruitment 2012-2014, and a substantial harvest of primarily breeding cows.

Modeling by Boulanger et al. (2014c) suggested that harvest alone could not account for the reduction in numbers of breeding females from 2010 to 2014 in this herd, thus low natural survival rates likely contributed to the herd's decline over this period. At overall cow survival rates of 73-75% (Boulanger et al. 2014c), the herd would not be able to maintain stability even with very high calf recruitment. Lower spring calf:cow ratios 2012 and 2014 may also be indicative of lower natural cow survival rates, given the correlation between calf recruitment and natural survival rates of caribou (Bergerud 2000). Condition of Bluenose-East hunter-killed cows from winters 2010-2014 was relatively poor, particularly in 2012 when low pregnancy rates were documented.

Reduced productivity and survival rates combined with substantial harvest of females from a declining herd have the potential to create a continued or accelerated decline, as was observed for the Bathurst herd from 2006-2009 (Adamczewski et al. 2009 In Prep, Boulanger et al. 2011). A similar pattern was found in the Cape Bathurst and Bluenose-West herds from 2000-2006 (Adamczewski et al. 2009 In Prep, Boulanger et al. 2011). In the case of the Bathurst herd, the annual decline in the herd accelerated from 11.7% between 2003 and 2006 to 33.1% between 2006 and 2009. The Bluenose-East herd

showed a similar annual decline rate of 16.4% 2010-2013, and the decline may be accelerating as observed in other herd declines in the NWT.

There was no evidence for large-scale movement from the Bluenose-East herd to either of its neighbors (Bluenose-West and Bathurst herds) from 2010-2014, based on the high fidelity of collared cows returning annually to the Bluenose-East calving ground (Figure 19).

PERSONNAL COMMUNICATION

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LITERATURE CITED

Adamczewski, J., J. Boulanger, B. Croft, H.D. Cluff, B. Elkin, J. Nishi, A. Kelly, A. D'Hont, and C. Nicolson. 2009 In Prep. Decline in the Bathurst caribou herd 2006-9: A technical evaluation of field data and modeling. Environment and Natural Resources, Government of Northwest Territories.

Adamczewski, J., J. Boulanger, B. Croft, T. Davison, H. Sayine-Crawford, and B. Tracz. 2014. A comparison of calving and post-calving photo-surveys for the Bluenose-East herd of barren-ground caribou in the Northwest Territories, Canada in 2010. Environment and Natural Resources, Government of Northwest Territories. Manuscript Report 244. 57pp.

Advisory Committee for the Cooperation on Wildlife Management (ACCWM). 2014a. Taking Care of Caribou – The Cape Bathurst, Bluenose-West, and Bluenose-East Barren Ground Caribou Herds Management Plan (Final). c/o Wek'èezhìi Renewable Resources Board.

Advisory Committee for the Cooperation on Wildlife Management (ACCWM). 2014b. Technical Report on the Cape Bathurst, Bluenose-West, and Bluenose-East Barren-Ground Caribou Herds. T. Davison lead author. Companion Report to *Taking Care of Caribou*: The Cape Bathurst, Bluenose-West, and Bluenose-East Barren-Ground Caribou Herds Management Plan (Final). c/o Wek'èezhìi Renewable Resources Board.

ACCWM (Advisory Committee for Cooperation on Wildlife Management). 2014c. We have been living with the caribou all our lives: a report on information recorded during community meetings for *'Taking Care of Caribou – the Cape Bathurst, Bluenose-West, and Bluenose-East Barren-ground Caribou Herds Management Plan'*. c/o Wek'èezhìi Renewable Resources Board.

Barnaby, J. and D. Simmons. 2013. Bathurst caribou harvesters' gathering January 29-31, 2013. Gathering hosted by Tłı̨chǫ Government and Wek'èezhìi Renewable Resources Board. (Report available on the WRRB web-site).

Barrier, T.A. and C.J. Johnson. 2012. The influence of fire history on selection of foraging sites by barren-ground caribou. Ecoscience 19: 177-188.

BCMPC (Bathurst Caribou Management Planning Committee). 2004. A management plan for the Bathurst caribou herd, November 4, 2004. (Available from GNWT ENR, Yellowknife).

Beaulieu, D. 2012. Dene traditional knowledge about caribou cycles in the Northwest Territories. Rangifer Special Issue 20: 59-67.

Bergerud, A.T. 2000. Caribou, chapter 31 *in* Demarais, S. and P.R. Krausman (eds.): Ecology and management of large mammals in North America. Prentice-Hall, New Jersey, USA.

Bergerud, A.T., S.N. Luttich, and L. Camps. 2008. The return of caribou to Ungava. McGill-Queen's University Press, Montreal and Kingston, ON.

Boertje, R. and R. Stephenson. 1992. Effects of ungulate availability on wolf reproductive potential in Alaska. Canadian Journal of Zoology 70:2,441-2,443.

Boulanger, J., B. Croft, and J. Adamczewski. 2014a. An estimate of breeding females and analyses of demographic indicators from the Bathurst herd 2012 calving ground photographic survey. Environment and Natural Resources, Government of Northwest Territories. File Report No. 142. 91pp.

Boulanger, J., B. Croft, and D. Cluff. 2014b. Trends in size of the Bathurst caribou herd from the 2014 calving ground reconnaissance survey. Environment and Natural Resources, Government of Northwest Territories. Unpublished Report.

Boulanger, J., B. Croft, and J. Adamczewski. 2014c. An estimate of breeding females and analyses of demographics for the Bluenose-East herd of barren ground caribou: 2013 calving ground photographic survey. Environment and Natural Resources, Government of Northwest Territories. File Report No. 143. 90pp.

Boulanger, J., B. Croft, and D. Cluff. 2014d. Trends in size of the Bluenose-East caribou herd from the 2014 calving ground reconnaissance survey. Environment and Natural Resources, Government of Northwest Territories. Unpublished Report.

Boulanger, J., A. Gunn, J. Adamczewski, and B. Croft. 2011. A data-driven demographic model to explore the decline of the Bathurst caribou herd. Journal of Wildlife Management 75:883-896.

Cameron, R.D. 1994. Reproductive pauses by female caribou. – Journal of Mammalogy 75(1): 10-13.

Cameron, R.D., W.T. Smith, S.G. Fancy, K.L. Gerhart, and R.G. White. 1993. Calving success of female caribou in relation to body weight. Canadian Journal of Zoology 71:480-486.

Crête, M., S. Couturier, B.J. Hearn, and T.E. Chubbs. 1996. Relative contribution of decreased productivity and survival to recent changes in the demographic trend of the Rivière George Caribou Herd. Rangifer Special Issue 9: 27-36.

Dauphine, T.C. 1971. Physical variables as an index to condition in barren-ground caribou. Transactions of the Northeast Section of the Wildlife Society 28:91-108.

Dauphine, T.C. 1976. Biology of the Kaminuriak population of barren-ground caribou. Part 4. Growth, reproduction and energy reserves. Canadian Wildlife Service Report Series 38. 71pp.

Davison, T.M., H. Sawada, P. Spencer, M. Branigan, and R. Popko. 2014. Calving ground fidelity of the Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-West and Bluenose-East barren-ground caribou herds. Environment and Natural Resources, Government of the Northwest Territories. Poster presentation at the 15th North American Caribou Workshop, 12-16 May 2014, Whitehorse, YK.

Fancy, S.G., K.R. Whitten, and D.E. Russell. 1994. Demography of the Porcupine caribou herd 1983-1992. Canadian Journal of Zoology 72:840-846.

Fuller, T.K. 1989. Population dynamics of wolves in north-central Minnesota. Wildlife Monographs: 3-41.

Fuller, T.K., L.D. Mech, and J.F. Cochrane. 2003. Wolf population dynamics. Pages 161-191 *in* Wolves: behavior, ecology, and conservation. University of Chicago Press, Chicago, IL.

Griffith, B., D.C. Douglas, N.E. Walsh, D.D. Young, T.R. McCabe, D.E. Russell, R.G. White, R.D. Cameron, and K.R. Whitten. 2002. Section 3: the Porcupine Caribou Herd. USGS/BRD 2002-0001 Biological Science Report.

Gronquist, R.M., T,L. Haynes and C.L. Gardner. 2005. Rebuilding the Fortymile caribou herd: a model of cooperative management planning. Rangifer Special Issue 16: 163-175.

Gunn, A. 2003. 2003. Voles, lemmings and caribou – population cycles revisited? Rangifer Special Issue 14: 105-111.

Gustine D.D., T.J. Brinkman, M.A. Lindgren, J.I. Schmidt, T.S. Rupp, and L.G. Adams. 2014. Climate-Driven Effects of Fire on Winter Habitat for Caribou in the Alaskan-Yukon Arctic. PLoS ONE 9(7): e100588. doi:10.1371/journal.pone.0100588.

Joly, K., P.A. Duffy, and T.S. Rupp. 2012. Simulating the effects of climate change on fire regimes in Arctic biomes: implications for caribou and moose habitat. Ecosphere 3(5):36 http://dx.doi.org/10.1890/ES12-00012.1.

Joly, K., D.R. Klein, D.L. Verbyla, T.S. Rupp and F.S. Chapin III. 2011. Linkages between large-scale climate patterns and the dynamics of Arctic caribou populations. Ecography 34:345-352.

Keith, L.B. 1983. Population dynamics of wolves. Wolves in Canada and Alaska: their status, biology, and management. Canadian Wildlife Service Report Series. No. 45:66-77.

Klaczek, M., R. Johnson, and H.D. Cluff. 2014 In Prep. Population dynamics and movement characteristics of tundra wolves denning on barren-ground caribou range in the central Canadian Arctic. Environment and Natural Resources, Government of the Northwest Territories.

Manseau, M., J. Huot, and M. Crête. 1996. Effects of summer grazing by caribou on composition and productivity of vegetation: community and landscape level. Journal of Ecology 84: 503-513.

Neiland, K.A. 1970. Weight of dried marrow as indicator of fat in caribou femurs. Journal of Wildlife Management 34: 904-907.

Thomas, D. C. and H.P.L. Kiliaan. 1998. Fire–caribou relationships: (I) Physical characteristics of the Beverly herd, 1980-87. Canadian Wildlife Service Technical Report Series No. 309, Canadian Wildlife Service, Prairie and Northern Region, Edmonton, AB.

Thomas, D.C., S.J. Barry, and G. Alaie. 1996. Fire–caribou–winter range relationships in northern Canada. Rangifer, 16: 57–67.

Thomas, D.C., H.P.L. Kiliaan, and T.W.P. Trottier. 1998. Fire–caribou relationships: (III) Movement patterns of the Beverly herd in relation to burns and snow. Canadian Wildlife Service Technical Report Series No. 311, Canadian Wildlife Service, Prairie and Northern Region, Edmonton, AB.

Valkenburg, P., D. Kelleyhouse, J.L. Davis, and J.M. Ver Hoef. 1994. Case history of the Fortymile caribou herd, 1920-1990. Rangifer 14: 11-22.

Vors, L.S. and M. S. Boyce. 2009. Global declines of caribou and reindeer. Global Change Biology 15: 2,626-2,633.

WRRB (Wek'èezhìi Renewable Resources Board). 2010. Report on a hearing held by the Wek'èezhìi Renewable Resources Board 22-26 March and 5-6 August 2010 in Behchokǫ, NWT and reasons for decisions related to a joint proposal for the management of the Bathurst caribou herd. (Accessible on the WRRB web-site registry).

Zalatan, R., A. Gunn, and G.H.R. Henry: Long-term abundance patterns of barren-ground caribou using trampling scars on roots of *Picea mariana* in the Northwest Territories, Canada. Arctic, Antarctic and Alpine Research 38(4): 624-630.

APPENDIX 1. BLUENOSE EAST CARIBOU HEALTH AND CONDITION MONITORING 2010-2014 PRELIMINARY RESULTS

(Summarized by I. Stasiak, ENR, summer 2014); information gathered by Tłı̨chǫ hunters and monitors on community hunts.

Hunter Sampling Kits:

- Information requested:
    - Unique individual animal identification number
    - Date of harvest
    - Location of harvest
    - Hunter name
    - Comments: general and any observed abnormalities
    - Estimated age (calf, yearling, young adult, moderate adult, old adult)
    - Sex of caribou (male or female)
    - Pregnant – visual observation of fetus (yes or no)
    - Lactation status –milk in udder (yes or no)
    - Condition – hunter assessment (skinny, not bad, fat, very fat)
    - Measurement of back fat (ruler provided)
- Samples requested:
    - Kidney and Fat
    - Incisor bar for tooth aging
    - Metatarsus (bone marrow fat analysis)

Hunter Caribou Collection and Sampling Summary:

2010

- Total caribou sample kits submitted: 114
- Sample collection timing:
    - 43 harvested between January 16, 2010
        - Grandin Lake
    - 71 harvested on February 13, 2010
        - Grandin Lake
- Sex composition of harvest: 49 females, 52 males, and 13 not identified

2011

- Total caribou sample kits submitted: 19
- Sample collection timing:
    - harvested between February 7 and February 18, 2011
        - Whatì (n=17, location not specified)
- Sex composition of harvest: 12 females, two males, and five not identified

2012

- Total caribou sample kits submitted: 40
- Sample collection timing:
  - 32 harvested between on February 23, 2012 (Grandin River, Grandin Lake)
  - eight harvested March 4-5, 2012 (Location not specified)
- Sex composition of harvest: 31 females, six males, and three not identified

2013

- Total caribou sample kits submitted: 50
- Sample collection timing:
  - All harvested between on March 22-23, 2013 (Hottah Lake)
  - eight harvested March 4-5, 2012 (Location not specified)
- Sex composition of harvest: 20 females, six males, and 24 not identified

2014

- Total caribou sample kits submitted: 70
- Sample collection timing:
  - All harvested between on March 30-April 1, 2014 (Hottah Lake)
- Sex composition of harvest: 55 females, five males, and ten not identified

Age Estimated by Hunters

Teeth submitted to Matson's Laboratory for exact age determination by cementum analysis for 2010-2013.

2010

Estimated age of harvest (submitted by hunters):

- Cows
  - One calf
  - Five yearlings
  - 32 adults
- Bulls
  - Six calves
  - 16 yearlings
  - 24 adults
  - 28 age not recorded

Tooth Cementum Age

2010

Age range: 1- 11
Gender: M (bull), F (cow), and U (unspecified)
N= 35

Age	Number of Animals	M.F.U
1	5	4.1.0
2	11	3.3.5
3	10	6.1.3
4	2	2.0.0
5	4	2.0.2
6	0	0.0.0
7	1	0.1.0
8	0	0.0.0
9	1	0.1.0
10	0	0.0.0
11	1	0.0.1

2011

Age range: 1-13
Gender: M (bull), F (cow), and U (unspecified)
N=16

Age	Number of Animals	M.F.U
1	3	0.2.1
2	0	0.0.0
3	4	0.3.1
4	1	0.0.1
5	1	0.1.0
6	1	1.0.0
7	3	0.2.1
8	1	0.1.0
9	0	0.0.0
10	1	0.1.0
11	0	0.0.0
12	0	0.0.0
13	1	0.1.0

2012

Age range: 1-9
Gender: M (bull), F (cow), and U (unspecified)
N=36

Age	Number of Animals	M.F.U
1	1	0.1.0
2	5	1.4.0
3	8	1.6.1
4	9	2.6.1
5	3	0.2.1
6	2	0.2.0
7	4	0.4.0
8	0	0.4.0
9	4	0.4.0

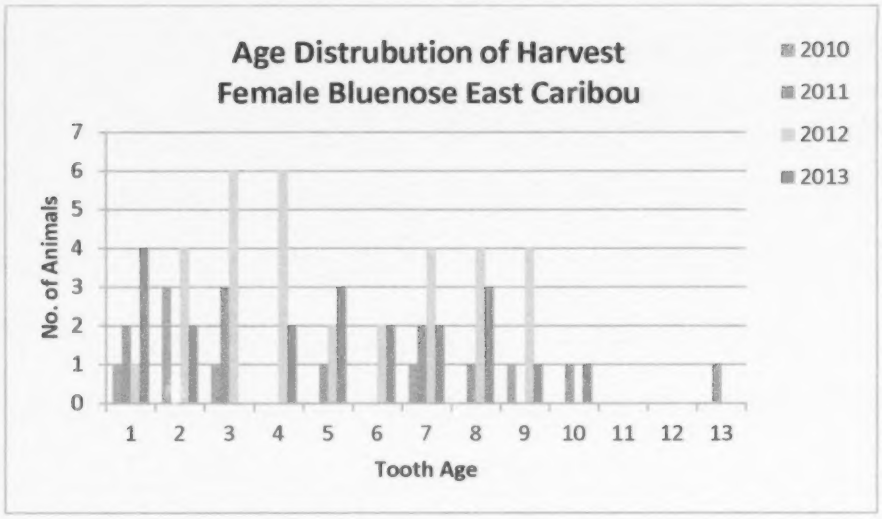
2013

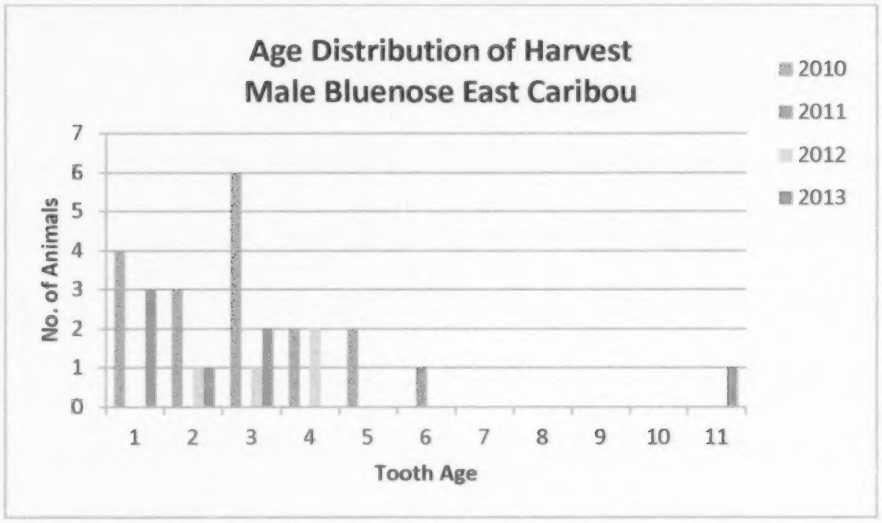
Age range: 1-13
Gender: M (bull), F (cow), and U (unspecified)
N=29

Age	Number of Animals	M.F.U
1	8	3.4.1
2	3	1.2.0
3	2	2.0.0
4	2	0.2.0
5	3	0.3.0
6	2	0.2.0
7	2	0.2.0
8	3	0.3.0
9	1	0.1.0
10	1	0.1.0
11	1	1.0.0
12	0	0.0.0
13	1	0.1.0

2014 Age Pending

Conclusion: a lot of young animals were harvested in 2013. This could suggest recruitment into the population which is good; however sample sizes are limited.





Field Assessment of Condition (Submitted by Hunters):

An assessment of the body condition of each caribou was done by hunters using a subjective condition score with four categories (skinny, not bad, fat and very fat). Hunter assessments suggested caribou were generally in generally good body condition for the age, sex and time of year, with a range in condition scores for each sampling interval.

2010

Not assessed

2011

- Cows
  - Very fat: 0
  - Fat: 2
  - Not bad: 9
  - Skinny: 1
- Bulls
  - Very fat: 0
  - Fat: 0
  - Not bad: 0
  - Skinny: 2
  - Not recorded: 6

2012

- Cows
  - Very fat: 0
  - Fat: 6
  - Not bad: 21
  - Skinny: 2
- Bulls
  - Very fat: 0
  - Fat: 0
  - Not bad: 6
  - Skinny: 0
  - Not recorded: 5

2013

- Cows
  - Very fat: 0
  - Fat: 3
  - Not bad: 11
  - Skinny: 6
- Bulls
  - Very fat: 0
  - Fat: 0
  - Not bad: 1
  - Skinny: 5
  - Not recorded: 25

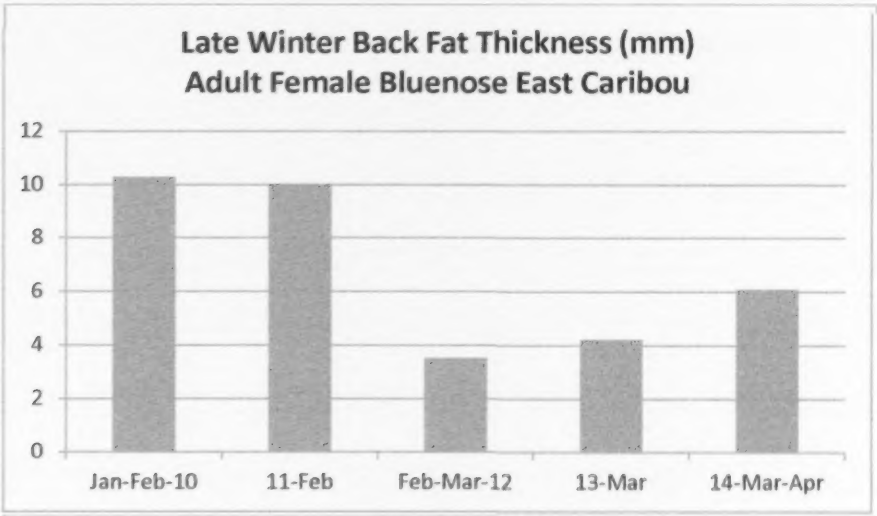
2014

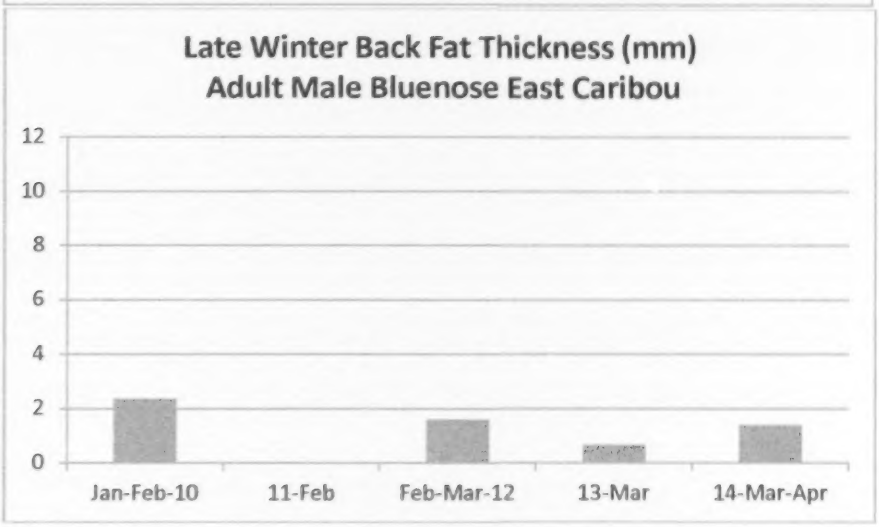
- Cows
  - Very fat: 0
  - Fat: 5
  - Not bad: 44
  - Skinny: 12
- Bulls
  - Very fat: 0
  - Fat: 0
  - Not bad: 2
  - Skinny: 3
  - Not recorded: 22
  - Conclusions: Bulls generally in worse body condition than cows – cows generally in good body condition. This supports what we know about cows/bulls at this time of year.

Back Fat Measurements:

Back fat measurements (mm) were taken by hunters by measuring the thickness of fat over the back at the base of the tail.

- **2010** Adult cows (n=45): mean 10.27±9.9 (range 0-38)
  Adult bulls (n=40): mean 2.35±4.0 (range 0-23)
- **2011** Adult cows (n=5): mean 10.0±10.0 (range 0-20)
  Adult bulls (n=1): mean 0
- **2012** Adult cows (n=29): mean 3.52±4.46 (range 0-15)
  Adult bulls (n=5): mean 1.60±3.58 (range 0-8)
- **2013** Adult cows (n=18): mean 4.22±5.43 (range 0-15)
  Adult bulls (n=6): mean 0.67±0.82 (range 0-2)
- **2014** Adult cows (n=44): mean 6.10±7.28 (range 0-35)
  Adult bulls (n=5): mean 1.40±1.34 (range 0-3)





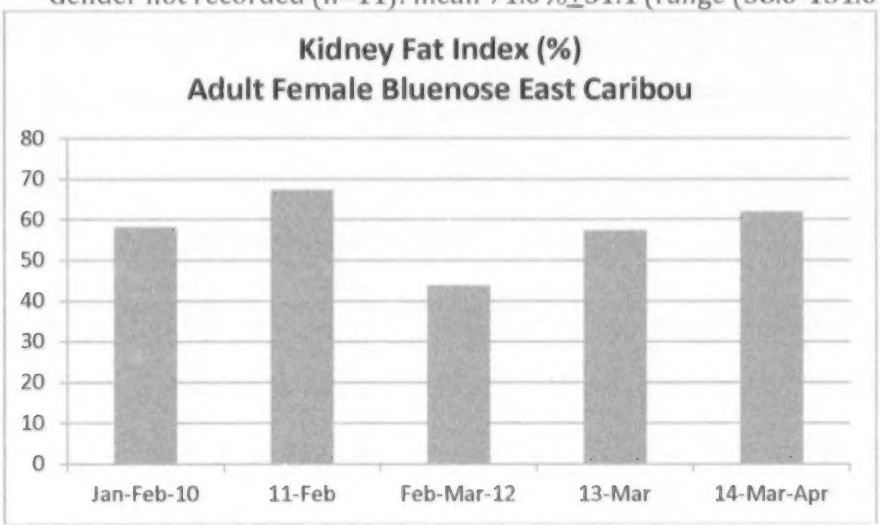
Conclusions: cows in generally better body condition than bulls – this supports hunter assessment of body condition data. Body condition of cows in 2014 was generally better than that in 2012 and 2013.

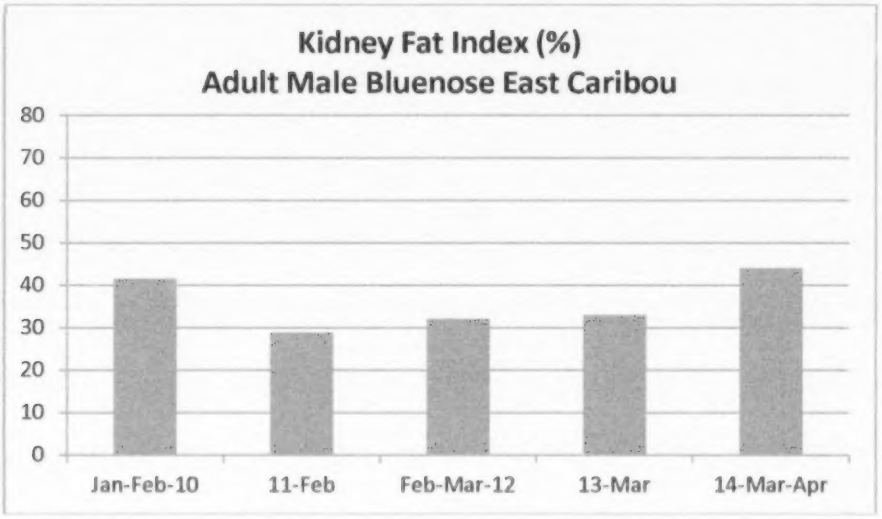
Kidney Fat:

Kidney fat index (KFI) is a widely used measure used as an indicator of abdominal fat reserves (Dauphine 1971, 1976). Kidneys were evaluated using a standardized technique to provide a ratio of the weight of the kidney fat to the weight of the kidney X 100; the KFI is reported as a percentage and can be >100%. The amount of kidney fat was variable

within and between sampling periods, with all animals having some amount of kidney fat stores.

- **2010** Adult cows (n=38): mean 58.2%±27.3 (range 0.5-114.1%)
  Adult bulls (n=39): mean 41.5%±29.9 (range 12.0-175.8%)
  Gender not recorded (n=9): mean 42.8%±7.3 (range (31.3-53.6%)
- **2011** Adult cows (n=12): mean 67.4%±30.5 (range 36.6-155.4%)
  Adult bulls (n=2): mean 28.9%±18.5 (range 15.8-42.0%)
  Gender not recorded (n=5): mean 48.9%±21.6 (range (18.7-72.2%)
- **2012** Adult cows (n=30): mean 43.8%±20.5 (range 12.43-92.3%)
  Adult bulls (n=6): mean 32.1%±11.4 (range 20.0-50.8%)
- **2013** Adult cows (n=21): mean 57.3%±23.3 (range 25.0-105.1%)
  Adult bulls (n=6): mean 33.0%±16.0 (range 11.5-49.3%)
- **2014** Adult cows (n=49): mean 62.0%±24.4 (range 13.0-129.0%)
  Adult bulls (n=5): mean 44.0%±20.5 (range 25.0-74.0%)
  Gender not recorded (n=11): mean 71.0%±31.1 (range (38.0-151.0%)





Conclusions: same as above – cows in better body condition than bulls. Caribou were generally in good body condition. KFI >30 is generally good body condition.

Generally, there appears to be an increasing trend in back fat and kidney fat stores from 2012-2014.

Bone Marrow Fat:

Fat content of the bone marrow has long been related to the physiological condition of animals. Neiland (1970) reported the percent fat in the marrow of barren-ground caribou was almost identical to percent oven-dry weight. Bone marrow fat is the last reserve to be mobilized and reflects condition only at the lower end of an overall animal condition after other body fat deposits have been exhausted. The results here are reported as the % oven dry-weight of bone marrow from the metatarsus.

- **2013** Adult cows (n=21): mean 83.0%±22 (range 37.0-130.8%)
  Adult bulls (n=7): mean 93.4%±5.9 (range 81.5-97.1%)
- **2014** Adult cows (n=55): mean 92.8%±5.4 (range 60.0-97.6%)
  Adult bulls (n=5): mean 86.6%±11.0 (range 67.6-96.0%)
  Gender not recorded (n=10): mean 90.9%±8.3 (range (68.0-97.3%)

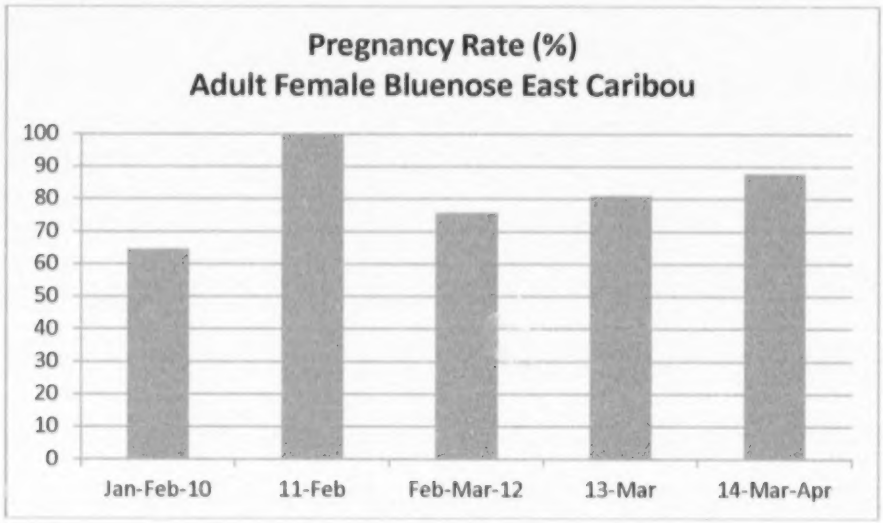
Bone marrow fat >75% is good body condition. Based on bone marrow assessment, animals were in good body condition. Fat stores are used up in order from subcutaneous fat (under the skin) to kidney fat, to bone marrow fat. Of the fat reserves that caribou have, bone marrow fat is generally the last to be used. Marrow fat is generally most useful as an

indicator of body condition at the lower end of the range, when animals are in really poor shape. In 2014, caribou had excellent bone marrow fat stores.

Pregnancy Rates:

Pregnancy rates were determined in late winter by the presence of a fetus.

- **2010** Adult cows: 31/48 (64.6%)
- **2011** Adult cows: 11/11 (100.0%)
- **2012** Adult cows: 22/29 (75.9%)
- **2013** Adult cows: 17/21 (81.0%)
- **2014** Adult cows: 44/50 (88.0%)



Pregnancy Data for Collared Caribou March 2012

Pregnancy status determined based on analysis of serum progesterone levels.

2010

Pregnancy rate: 8/9 (89.0%)

2012

Pregnancy rate: 27/42 (64.0%)

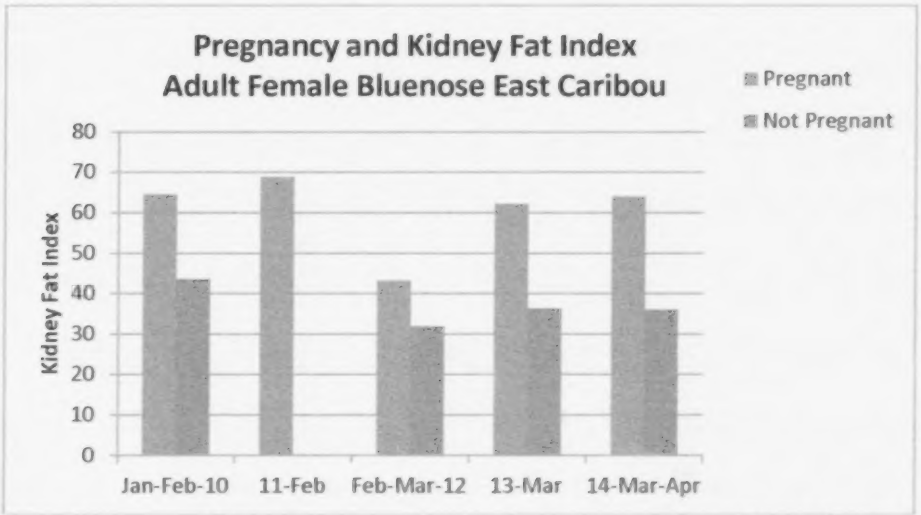
2014

Pregnancy rate: 7/8 (87.5%)

Hunter assessed pregnancy rates appear to be in line with those found through analysis of serum (blood) progesterone levels from collared caribou at the time of collaring, recognizing some of the limited sample sizes involved.

Kidney Fat Index in Relation to Pregnancy

- **2010** Pregnant (n=25): mean 64.6%±26.2 (range 3.2-114.1%)
  Not Pregnant (n=12): mean 43.6%±27.3 (range 0.5-95.1%)
- **2011** Pregnant (n=11): mean 68.8%±31.6 (range 36.6-155.4%)
  2012 Pregnant (n=22): mean 43.2%±18.2 (range 12.43-73.5%)
  Not pregnant (n=6): mean 31.9%±12.2 (range 16.6-50.0%)
- **2013** Pregnant (n=17): mean 62.2%±21.9 (range 35.5-105.1%)
  Not pregnant (n=4): mean 36.3%±18.3 (range 25.0-63.4%)
- **2014** Pregnant (n=40): mean 64.0%±23.3 (range 16.0-129.0%)
  Not Pregnant (n=4): mean 36.0%±29.8 (range 13.0-79.0%)



Pregnant caribou generally appear to have higher kidney fat index (aka better body condition) than those that were not pregnant. This supports the importance of good body condition in maintaining reproductive potential of the herd.

Generally, animals appeared to be in better body condition in 2014 than in the previous two years. This was reflected by a higher recorded pregnancy rate. Since interpretation is limited by a small sample size, trends are not statistically validated; however, they do give some indication of the health status of the herd. The sample size obtained in 2014 was larger than that in previous years which gives more strength to the data.

APPENDIX 2: STABLE, DECLINING AND INCREASING CARIBOU HERDS: A SIMPLE VIEW OF THE NUMBERS

Caribou herds can increase or decline at substantial rates. The three examples below are for a herd of 100,000 that is (1) stable, (2) declining, or (3) increasing, with corresponding survival and pregnancy rates. The calculations are simplified but realistic, and the rates of change, survival and pregnancy are based on known examples from caribou herds in North America. Even in a stable or increasing herd, there is high turnover and many caribou die every year. However, the deaths are spread out over large areas and over the entire year, and predators and scavengers usually dispose of dead caribou within a few days. Only in cases of mass die-offs (e.g. Peary caribou in 1974-1975) are large numbers of carcasses likely to be found, in situations where predators and scavengers are unable to keep up with the dead caribou available.

Example 1: Stable herd of 100,000
End of May: 60,000 cows, 40,000 bulls (1 year old or older), 83% pregnancy in the cows.

Just after calving in early June: 60,000 cows, 40,000 bulls, 50,000 newborn calves (total 150,000).

A year later (end of May again):

- Cows had mortality rate of 15% (survival 85%); 9,000 died, 51,000 lived.
- Bulls had mortality rate of 30% (survival 70%); 12,000 died, 28,000 lived.
- Calves had mortality rate of 58% (survival 42%); 29,000 died, 21,000 lived to one year.
- Total 51,000 cows + 28,000 bulls + 21,000 yearlings (male and female) = 100,000 (stable herd).
- Calf:cow ratio in May would be about 41 calves:100 cows.

Mortality rates of calves are always highest, bulls generally have higher mortality rates than cows, and cows usually have the lowest mortality rates. Assuming here that calves at one year (yearlings) have mortality rates similar to adults; they are usually similar.

Over that year, 9,000 + 12,000 + 29,000 died (50,000 total).

Example 2: Herd of 100,000 declining at 19%/year
(Note estimated Bluenose-East decline rate 2010-2013 was 16%/year)

End of May: 60,000 cows and 40,000 bulls, pregnancy rate of 67%.

Just after calving in June: 60,000 cows, 40,000 bulls, 40,000 calves (total 140,000).

A year later (end of May again):

- Cows had mortality rate of 25% (survival 75%); 15,000 died, 45,000 lived.
- Bulls had mortality rate of 35% (survival 65%); 14,000 died, 26,000 lived.
- Calves had mortality rate of 75% (survival 25%); 30,000 died, 10,000 lived.
- Total 45,000 + 26,000 + 10,000 = 81,000, decline of 19%.
- Calf:cow ratio in May would be about 22 calves:100 cows.

Over that year, 59,000 (15,000 + 14,000 + 30,000) caribou died.

Example 3: Herd of 100,000 growing at 13%/year
(Note George River caribou herd was increasing at an estimated 14%/year 1950s-1980s)

End of May: 60,000 cows and 40,000 bulls, pregnancy rate of 90%.

Just after calving in June: 60,000 cows, 40,000 bulls, 54,000 calves (total 154,000).

A year later (end of May again):

- Cows had mortality rate of 10% (survival 90%); 6,000 died, 54,000 lived.
- Bulls had mortality rate of 20% (survival 80%); 8,000 died, 32,000 lived.
- Calves had mortality rate of 50% (survival 50%); 27,000 died, 27,000 lived.
- Total 54,000 + 32,000 + 27,000 = 113,000, increase of 13%.
- Calf:cow ratio in May would be about 50 calves:100 cows.

Over that year, 41,000 (6,000 + 8,000 + 27,000) caribou died.